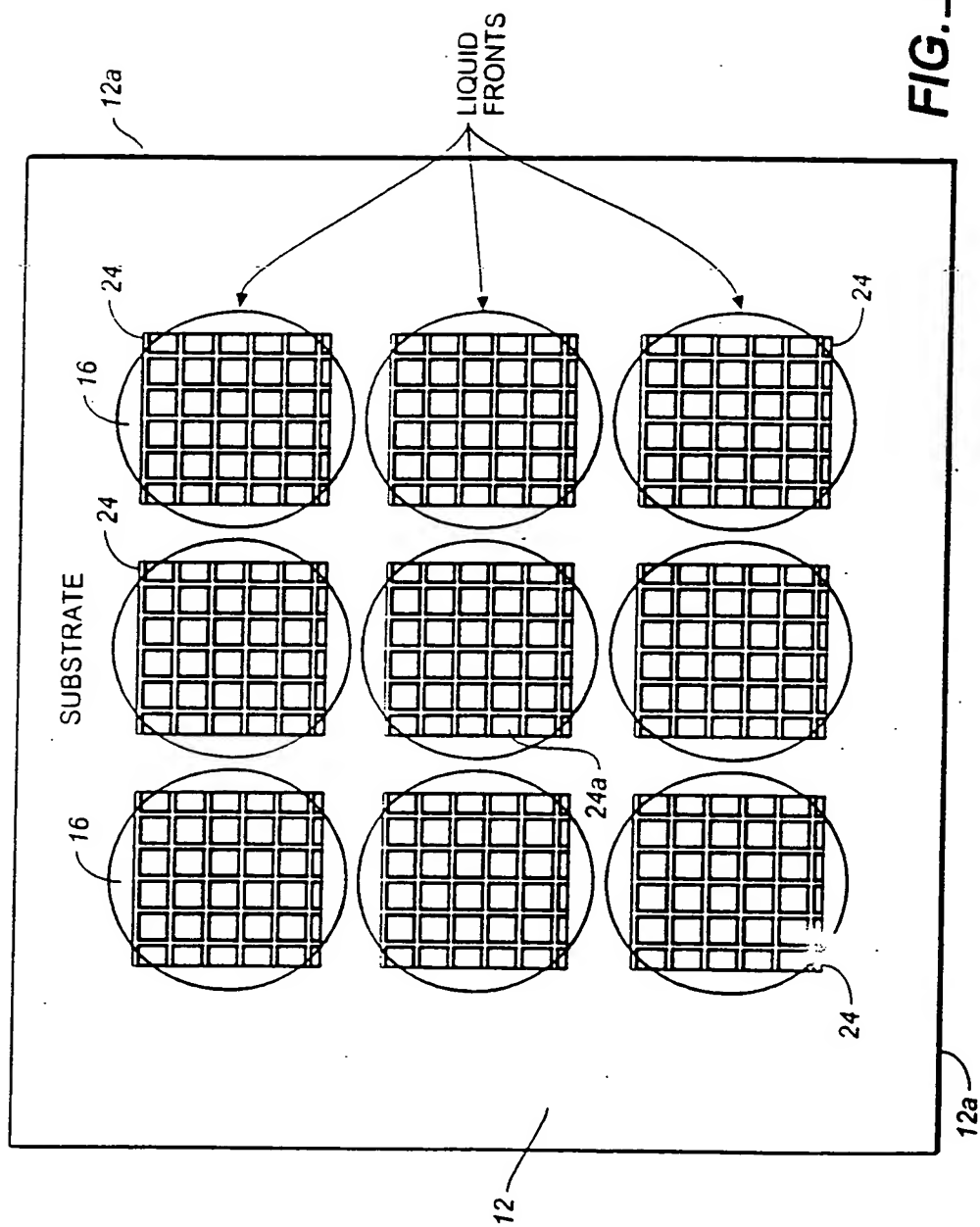




Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	



**FIG. 4**

1. Process Flow

1

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56

L/D Preparation

Fig. 5.

Fig. 6

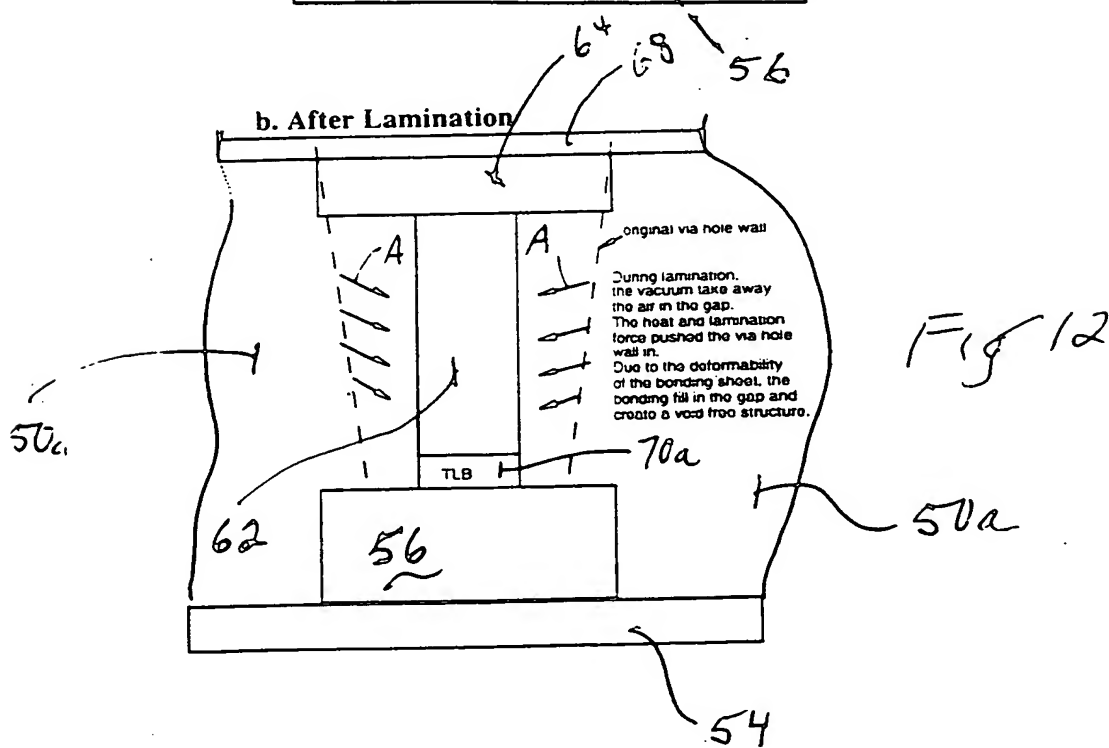
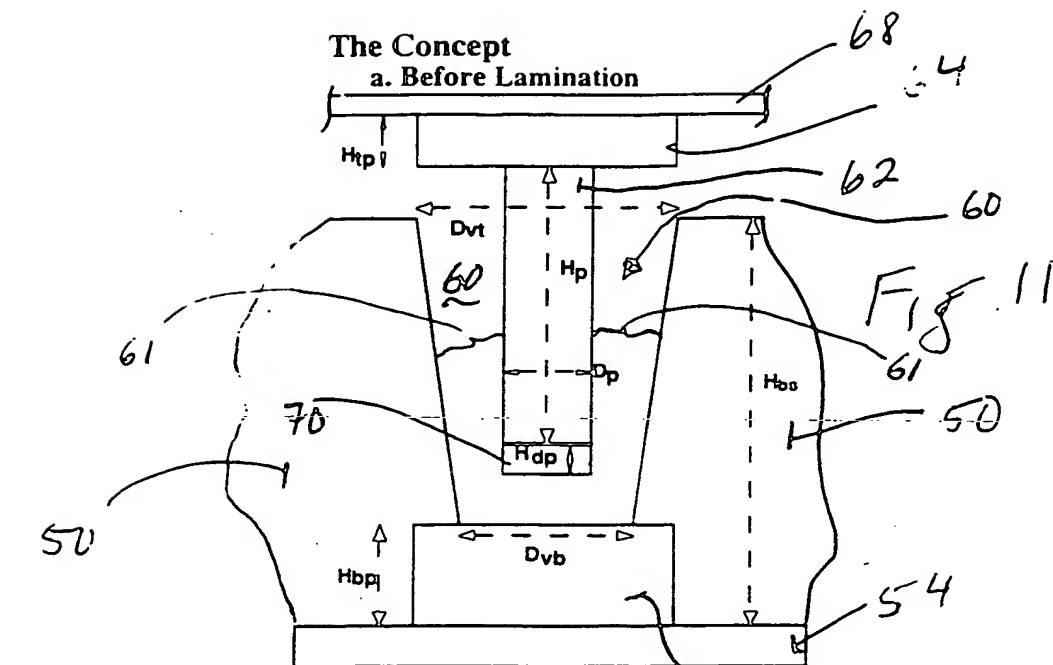
Fig. 7

Fig. 8

Fig. 9

Fig. 10

10065495 020103



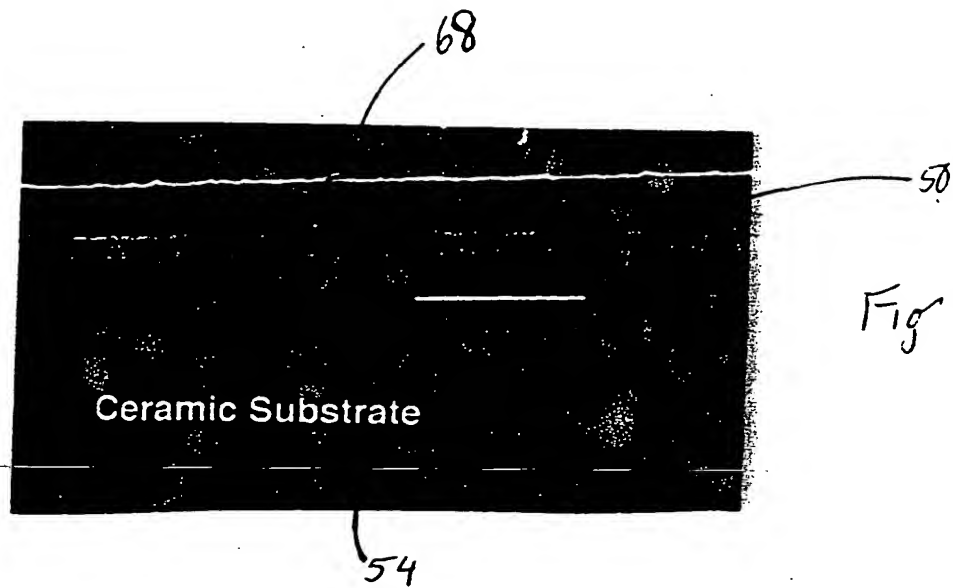


Fig 13

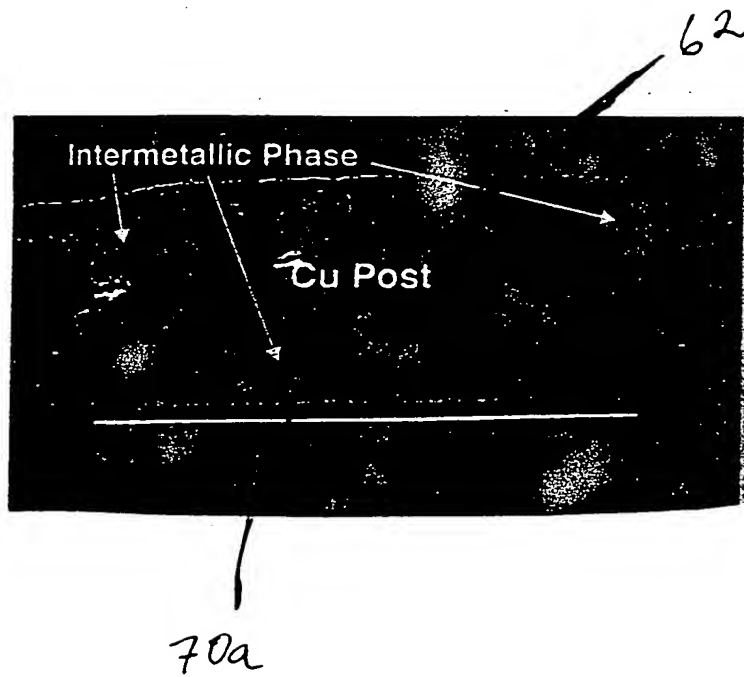
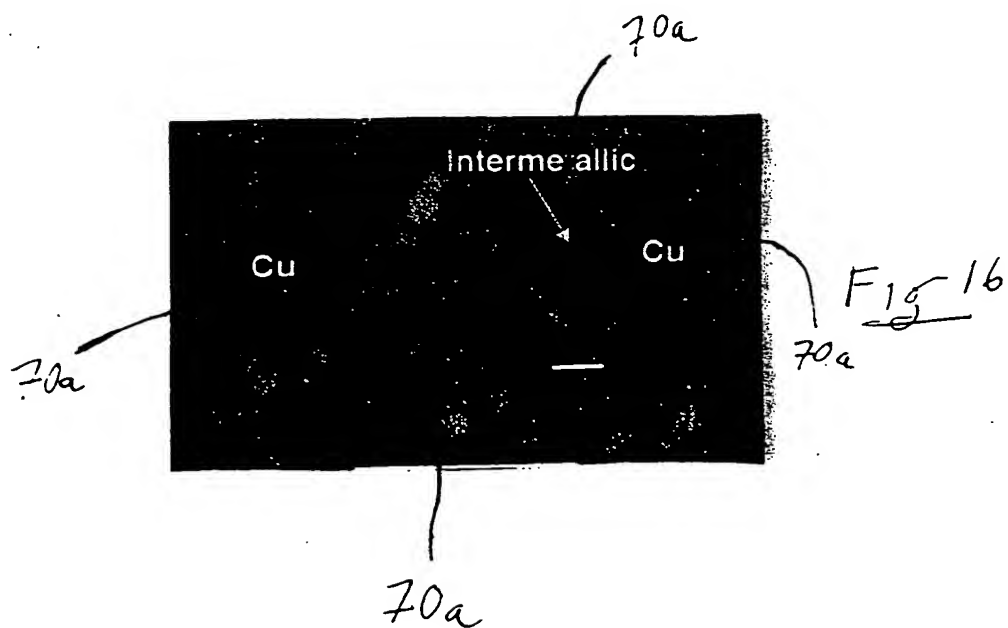
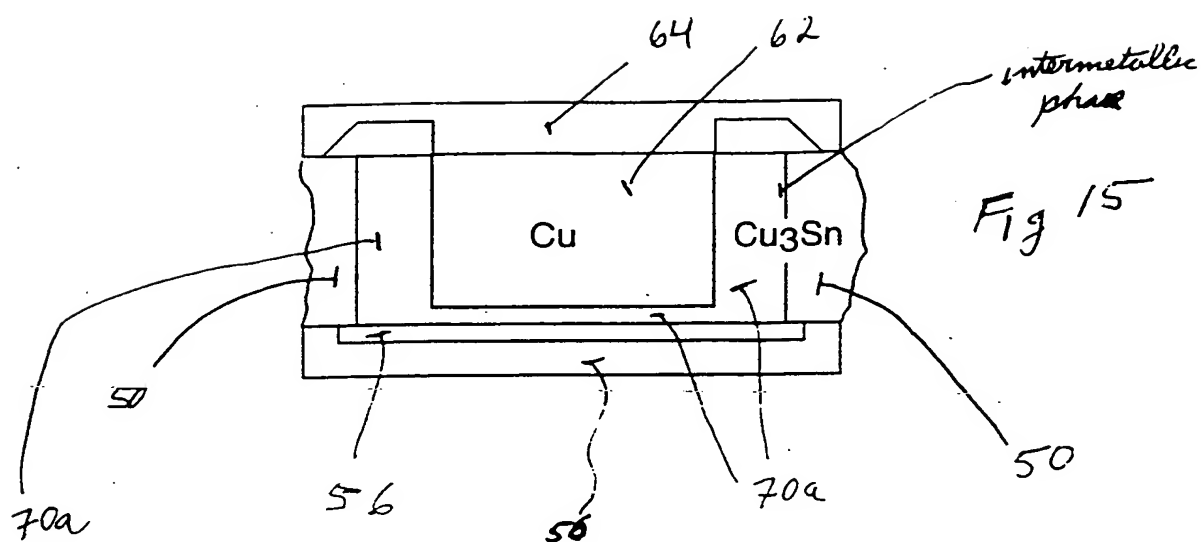
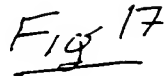


Fig 14



84



86

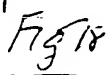
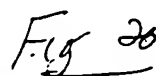


Fig 19



66





After lamination at suitable temperature for both bonding sheet and Transient Liquid Alloy Joints, the final structure has a filled via with metal post embedded inside intermetallic wall.

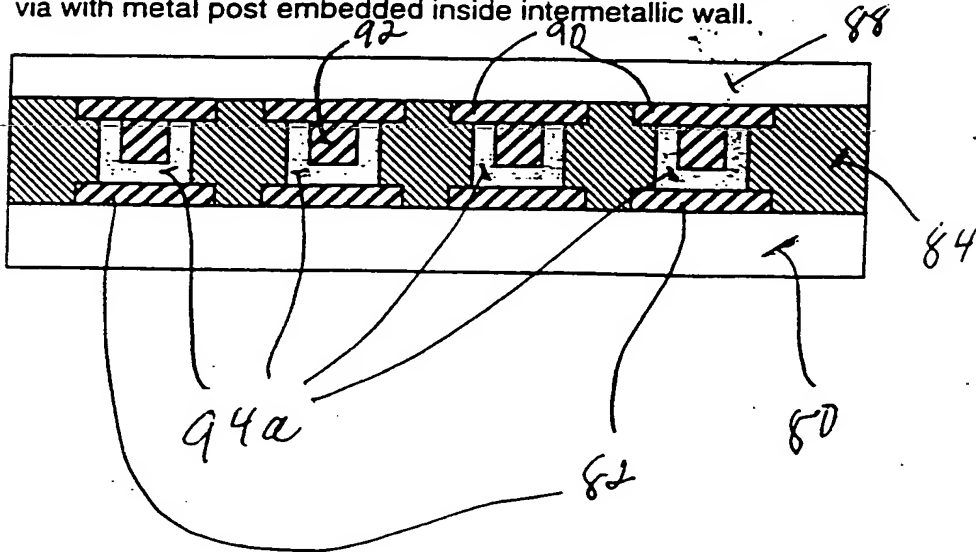


Fig 21

1006496 000100

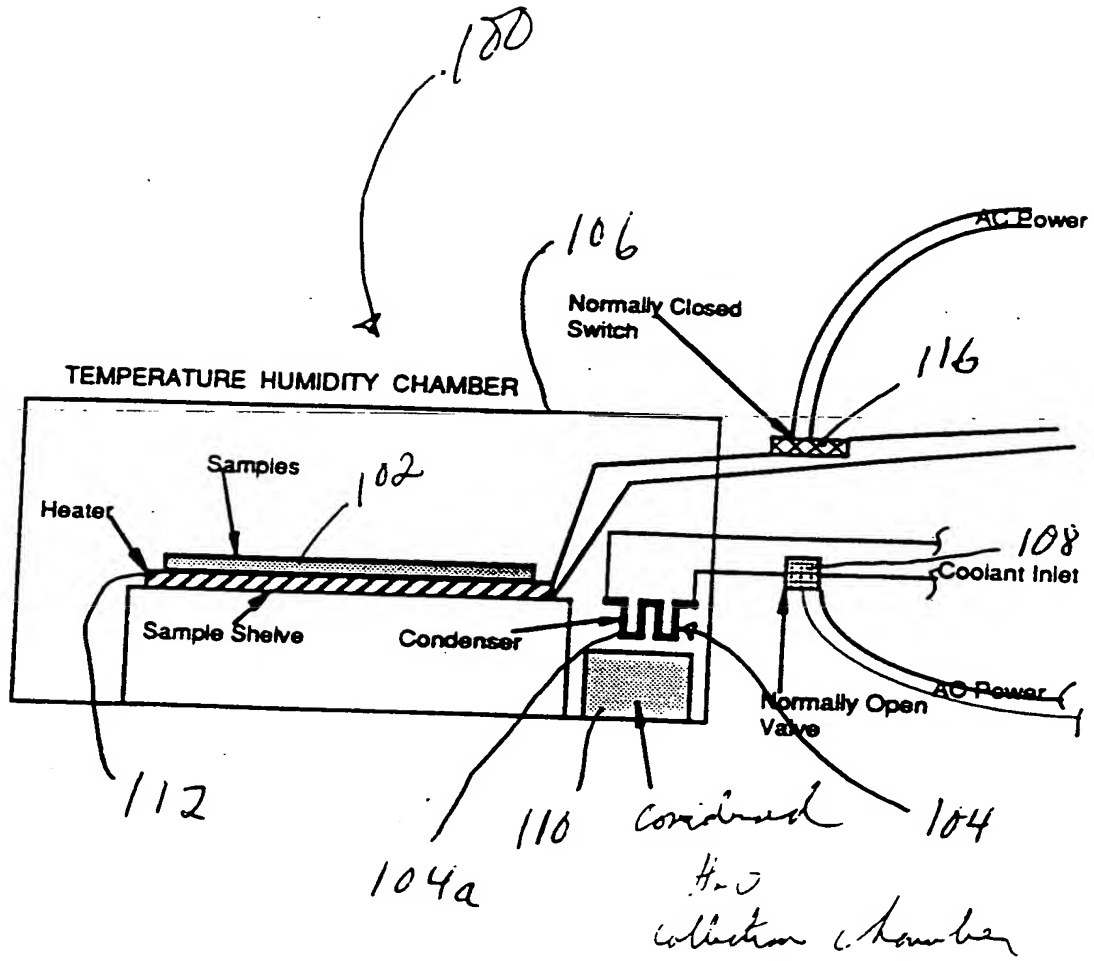


Fig 22

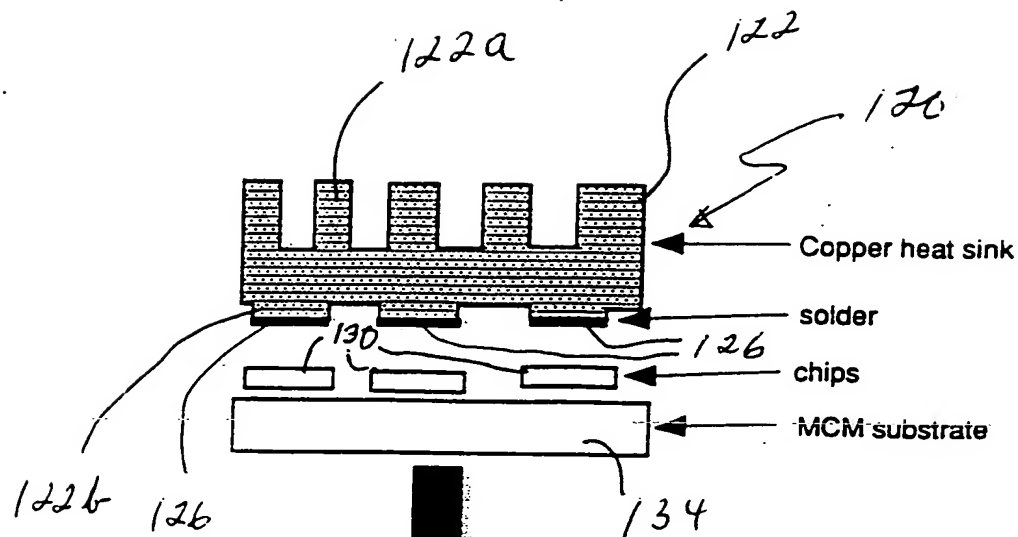


Fig. 23

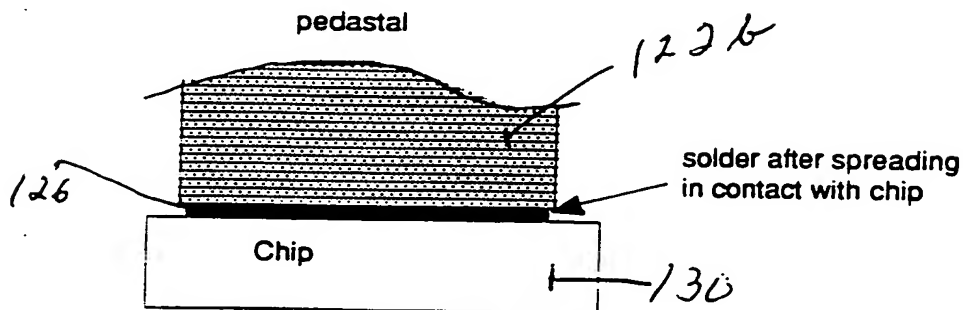
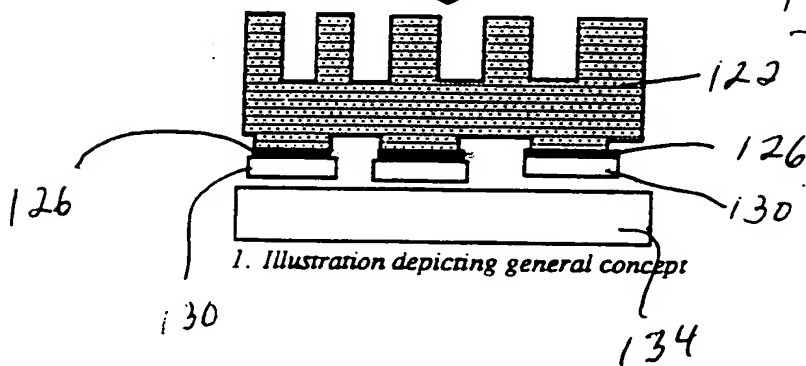


Fig 24

10065455 020103

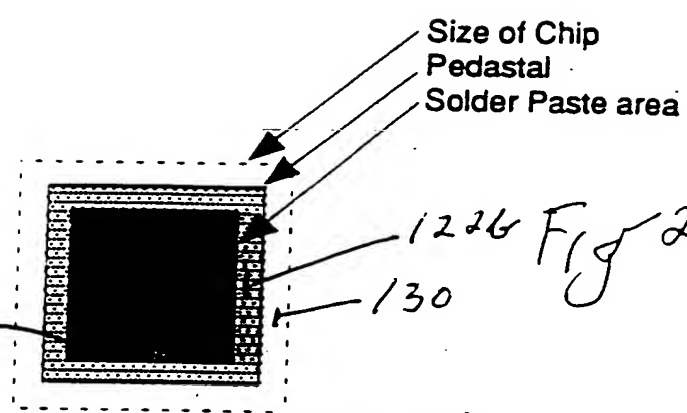
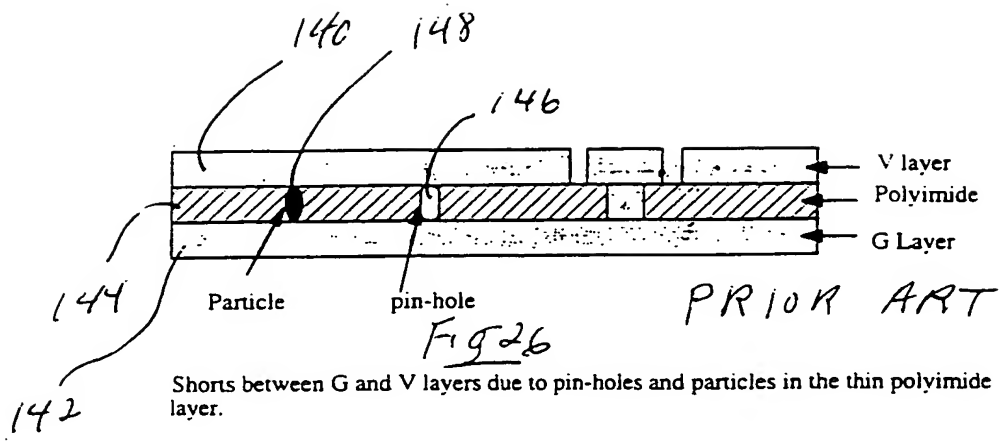


Fig 25

3. Illustration of top view of pedestal

126

10055495 020102 201020 55495001



The New Process

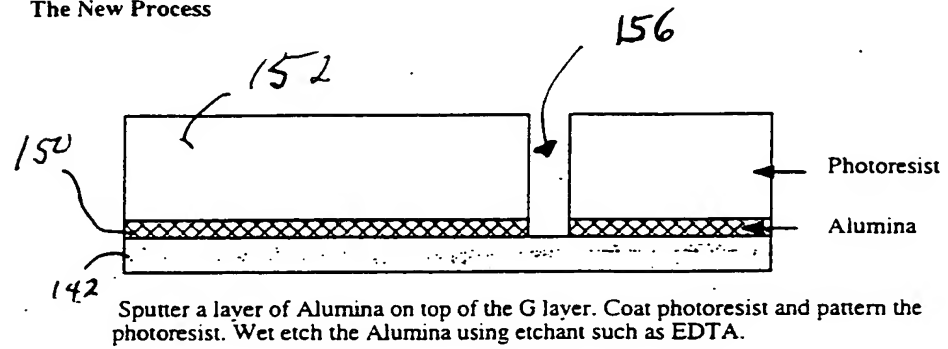


Fig 27

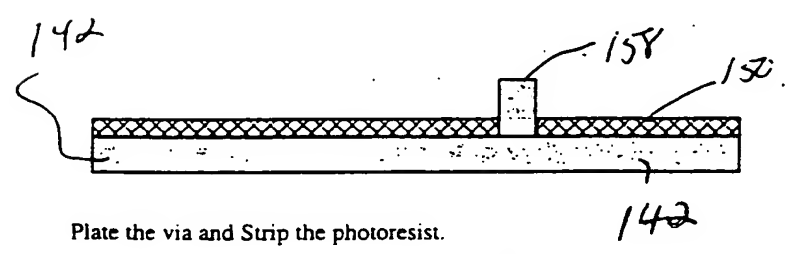
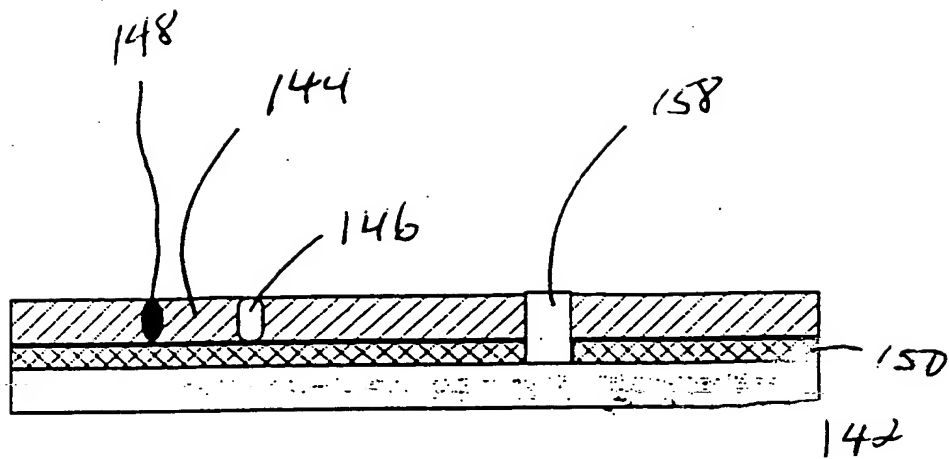
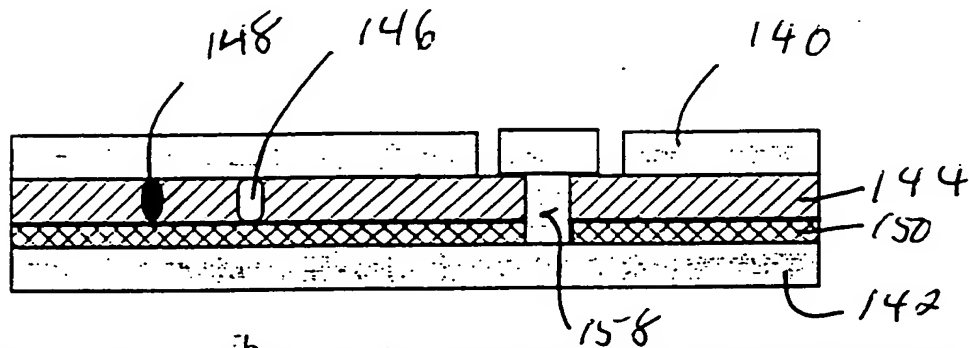


Fig 28



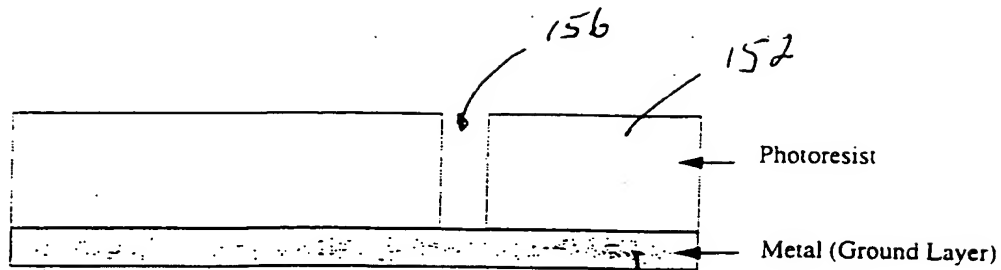
Coat polyimide, and then planarize and expose the vias.

Fig 29



Build V layer. Even there are pin-holes and particles in the polyimide layer, no shorts occur between G and V layers.

Fig 30



Coat photoresist and pattern the photoresist.

Fig 31  
142

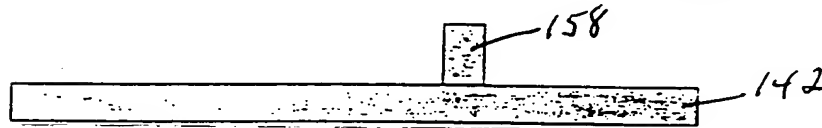
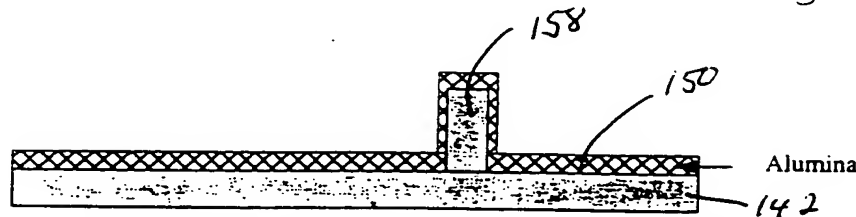


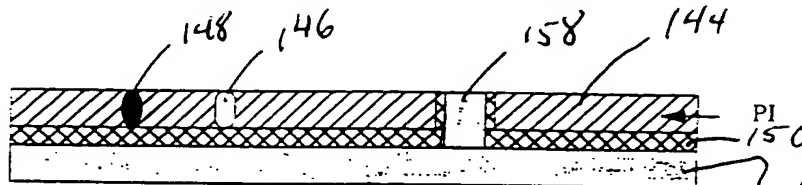
plate vias, strip resist. and etch seed (if needed)

Fig 32



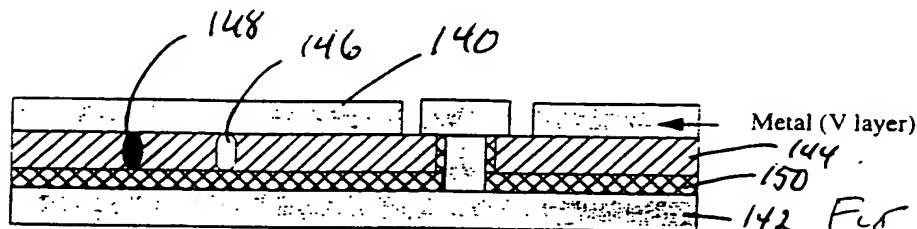
Deposit alumina (or other type of dielectric materials). Deposition processes include CVD, PVD, or sol-gel process.

Fig 33



Coat PI layer and then planarize and expose the vias

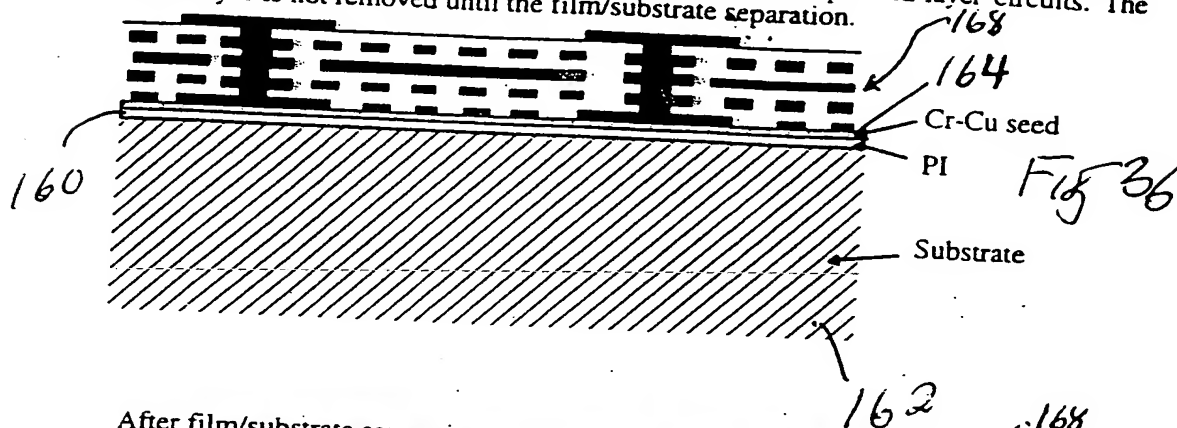
Fig 34  
142



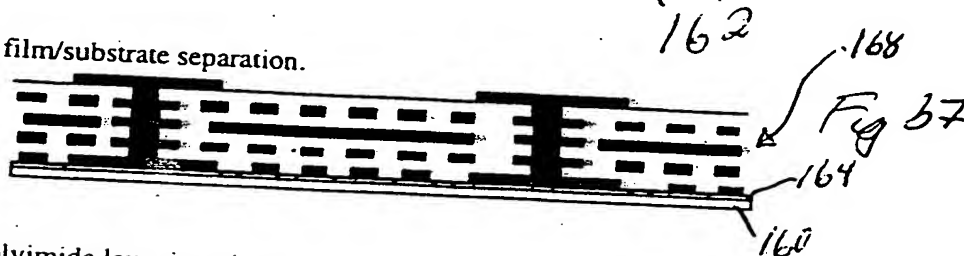
Build V layer. Even there are pinholes and particles in the polyimide layer, no shorts occur between G and V layers.

Fig 35  
142

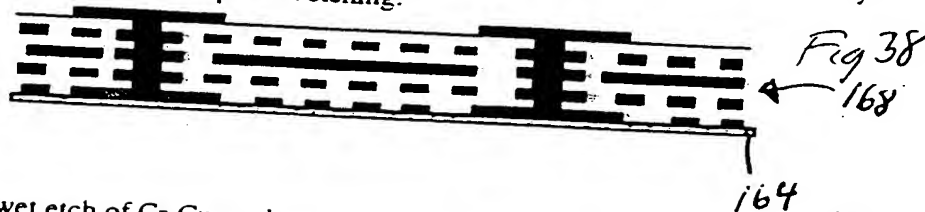
Coat a polyimide layer on top of a substrate. The substrate may be pre-treated for later film/substrate separation. Sputter Cr-Cu seed, and build up multi-layer circuits. The Cr-Cu seed layer is not removed until the film/substrate separation.



After film/substrate separation.



The polyimide layer is etched away using oxygen plasma. The Cr-Cu seed layer serves as the stop-layer for the plasma etching.



After wet etch of Cr-Cu seed.

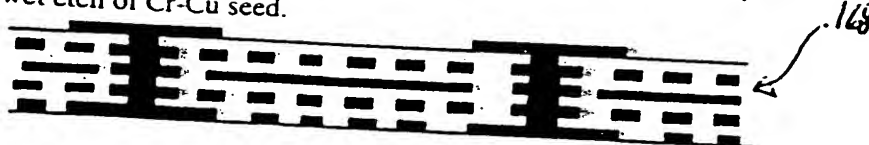


Fig 39



Fig. 40 Coat a polyimide layer on top of a substrate and sputter Cr-Cu seed on top of the polyimide. The substrate may be pre-treatment for later film/substrate separation. The seed is etched away after completing the first metal pattern layer. Multi-layer circuits are then built.

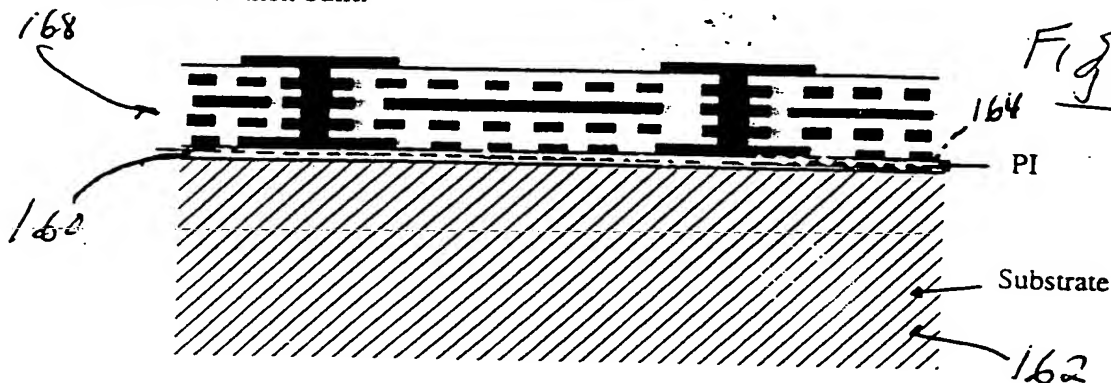


Fig. 41 After film/substrate separation

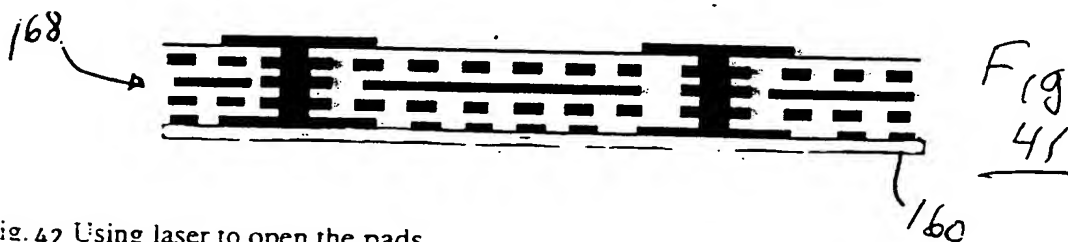
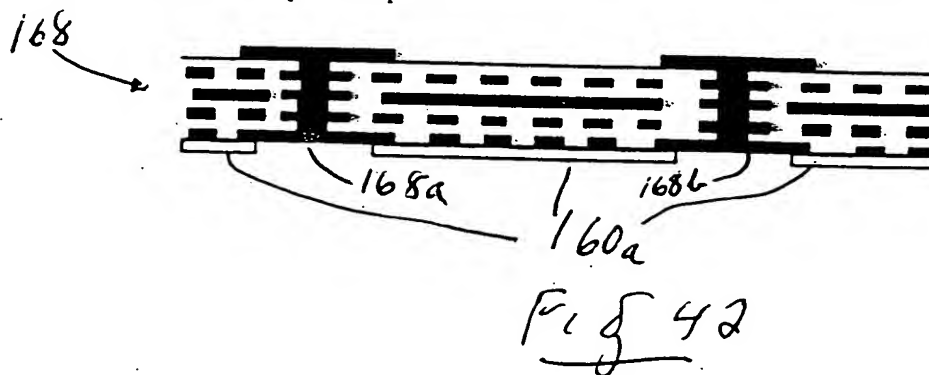


Fig. 42 Using laser to open the pads



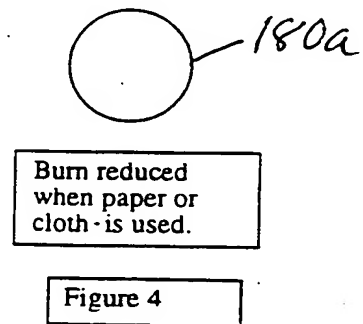
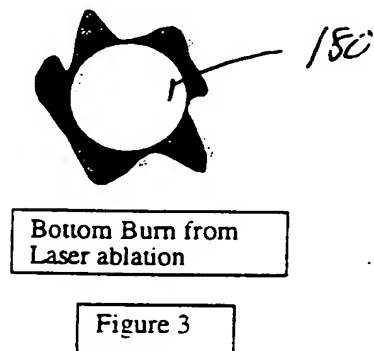
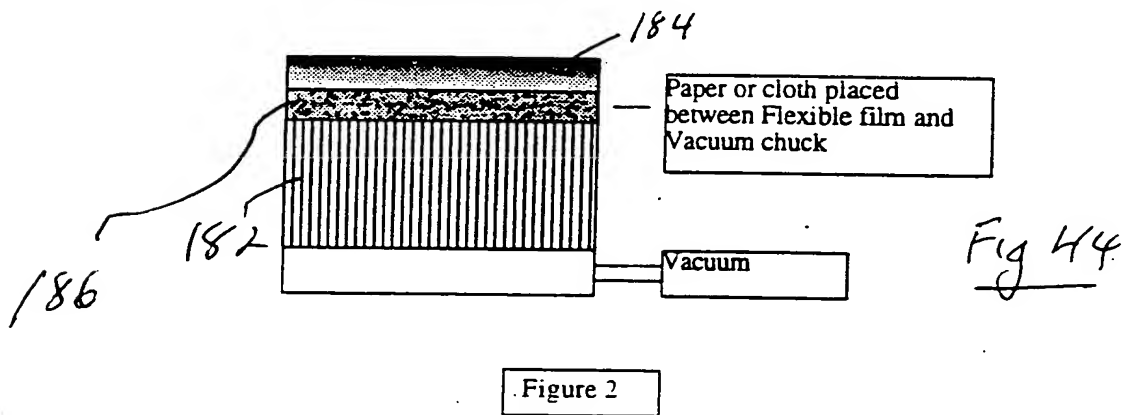
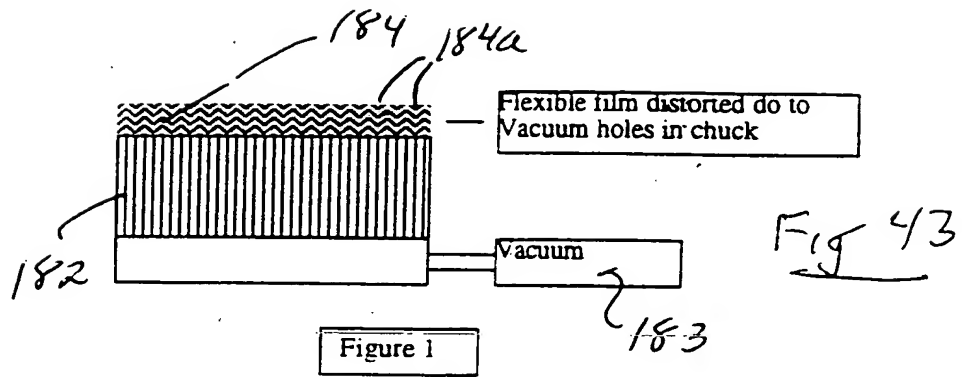
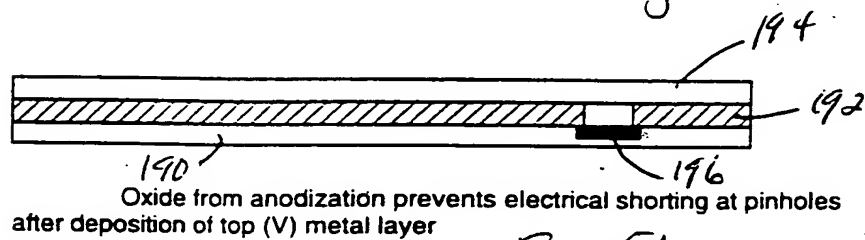
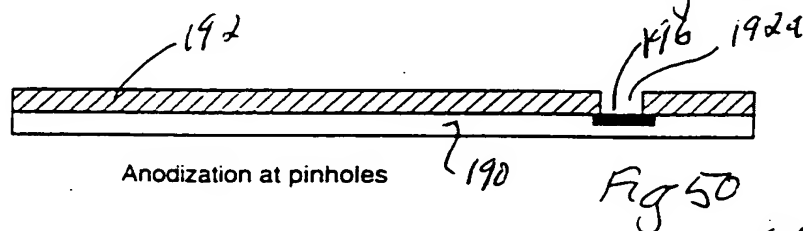
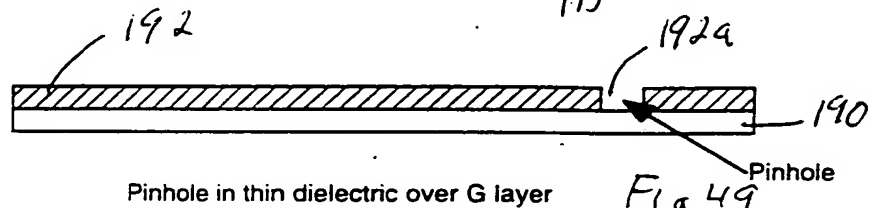
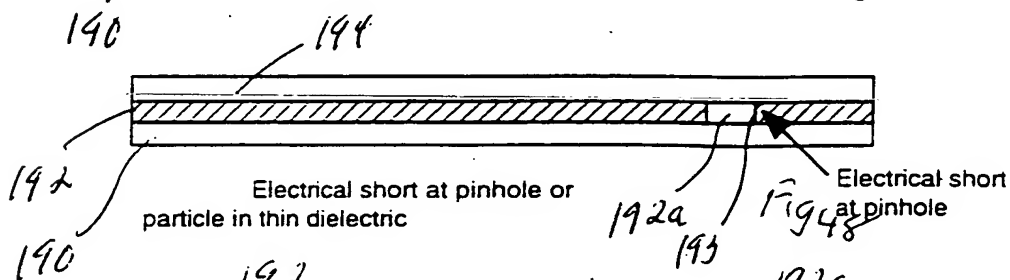
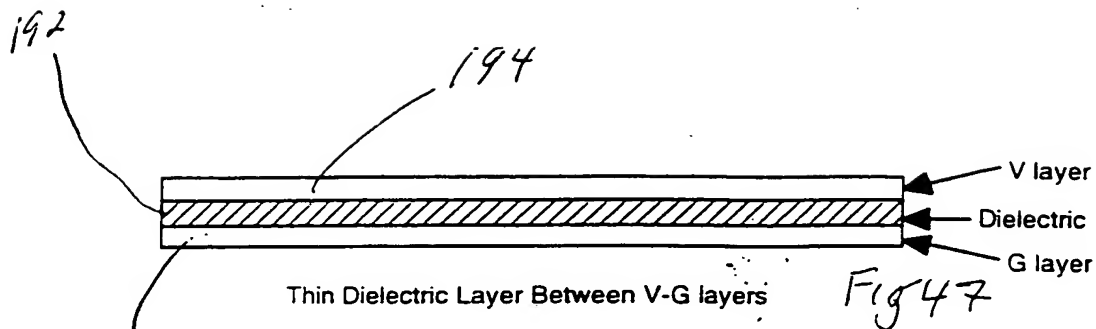


Fig 45

Fig 46



10056498.00000000

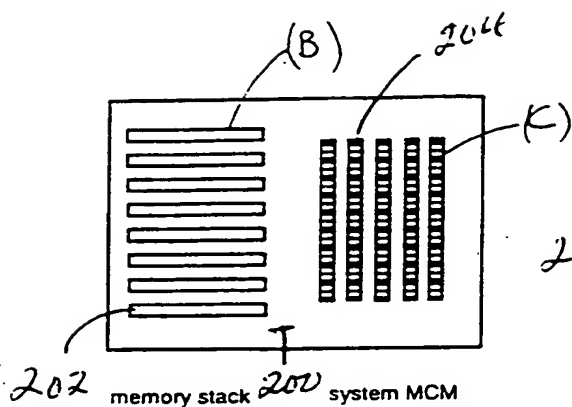


Fig 52A

Case (I)

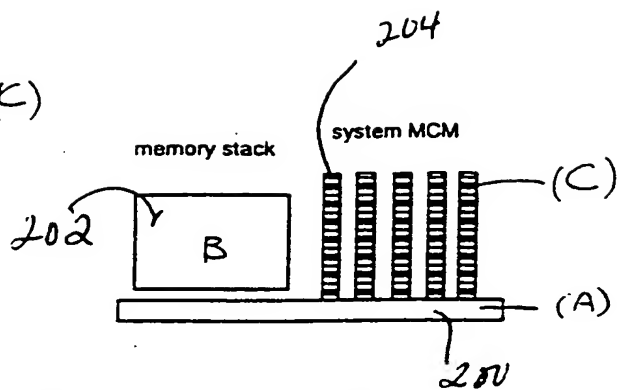


Fig 52B

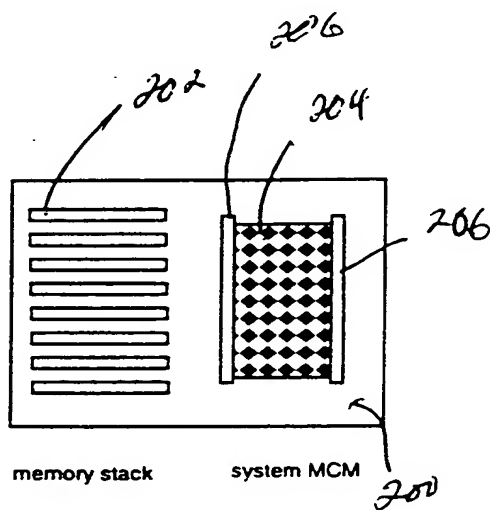


Fig 53A

Case (II)

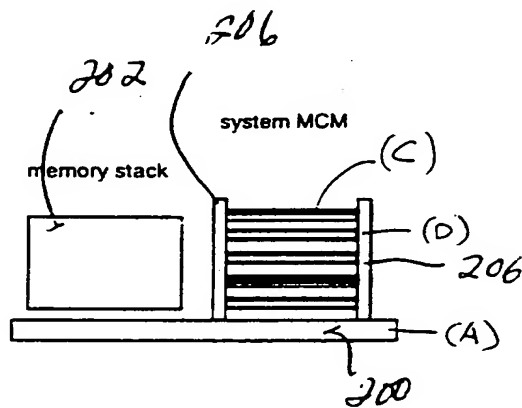


Fig 53B

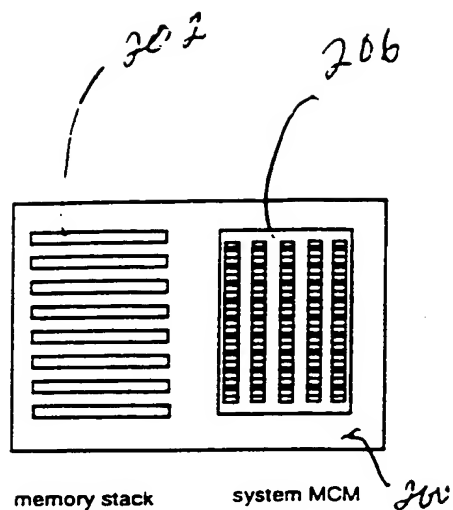


Fig 54A

Case (II)

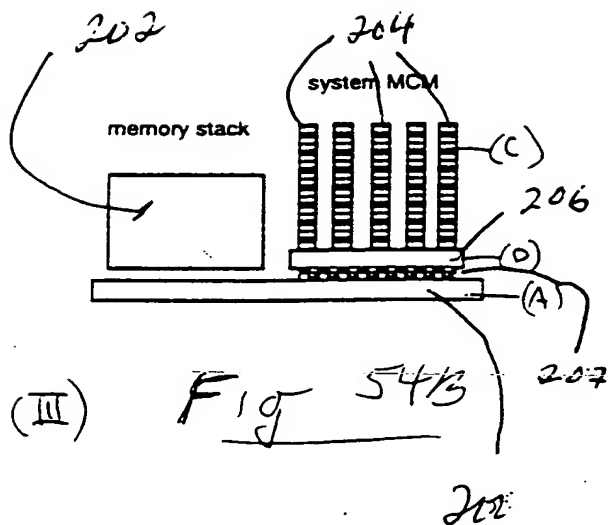


Fig 54/3

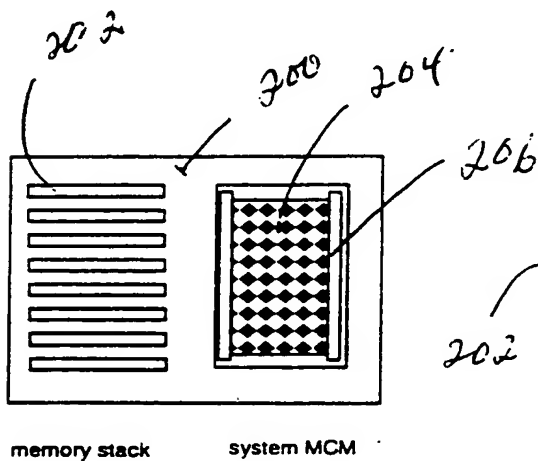


Fig 55A

Case (IV)

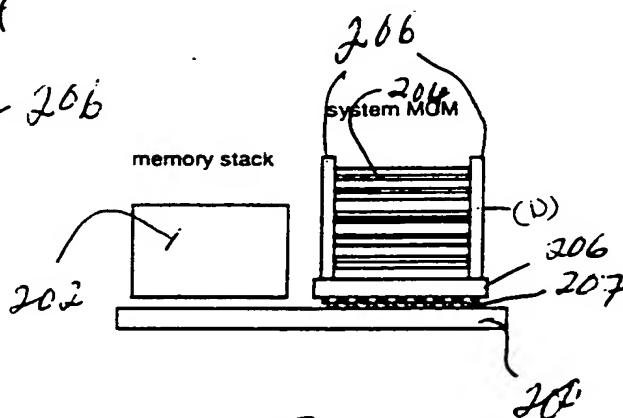


Fig 55B

1005433-200408

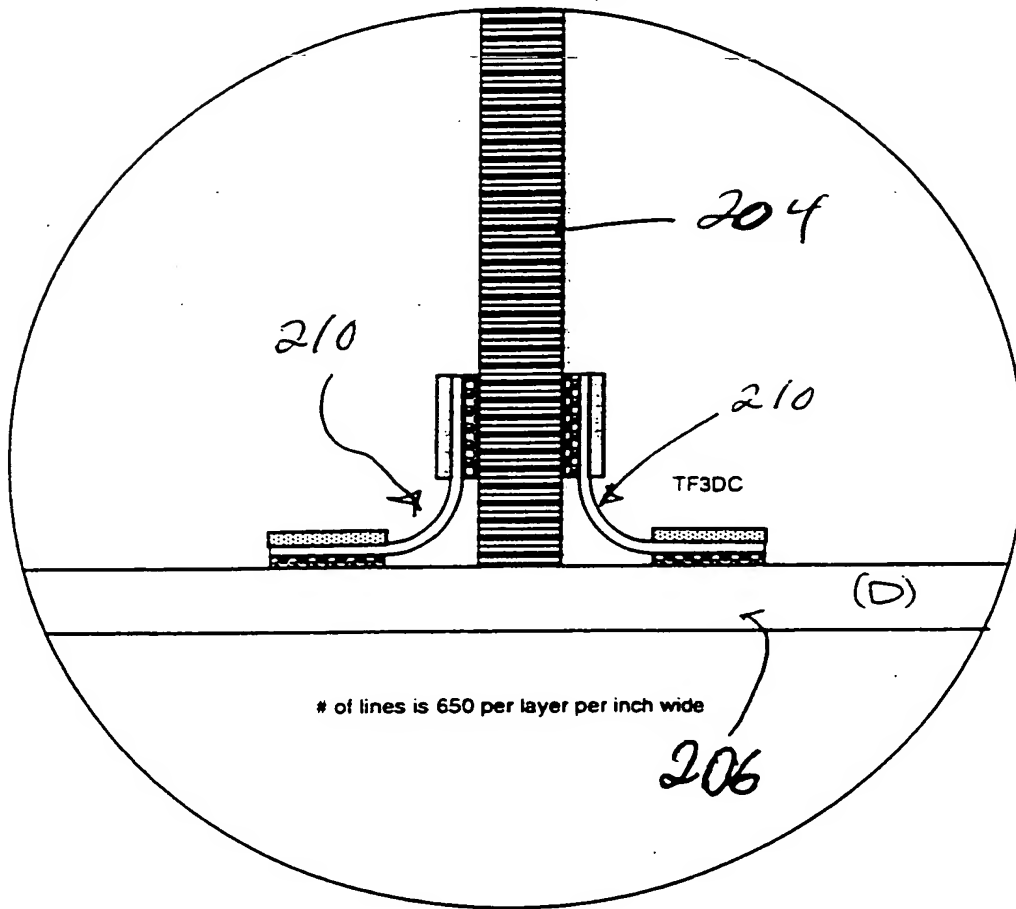
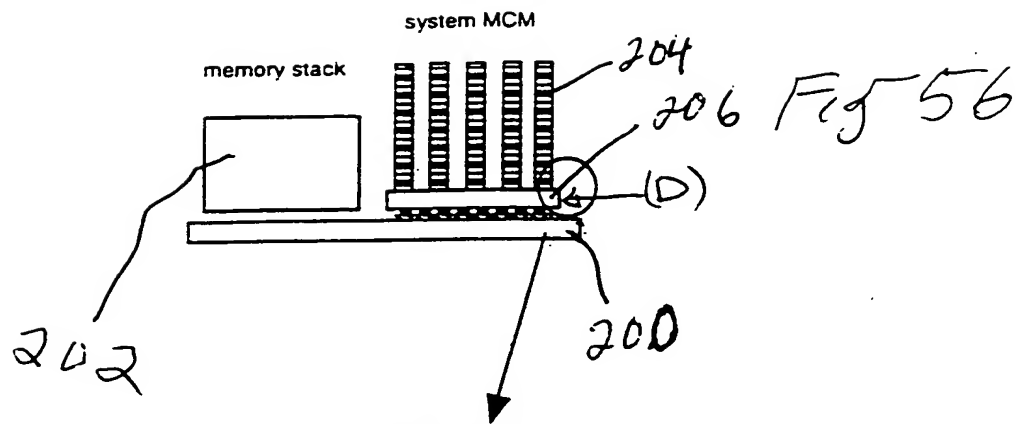


Fig 57

10054155 020402

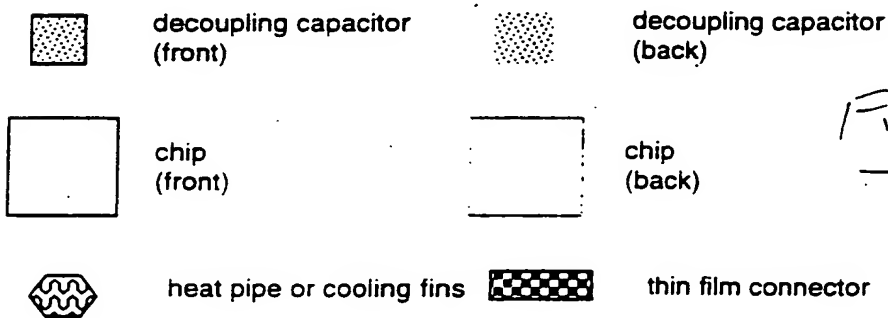
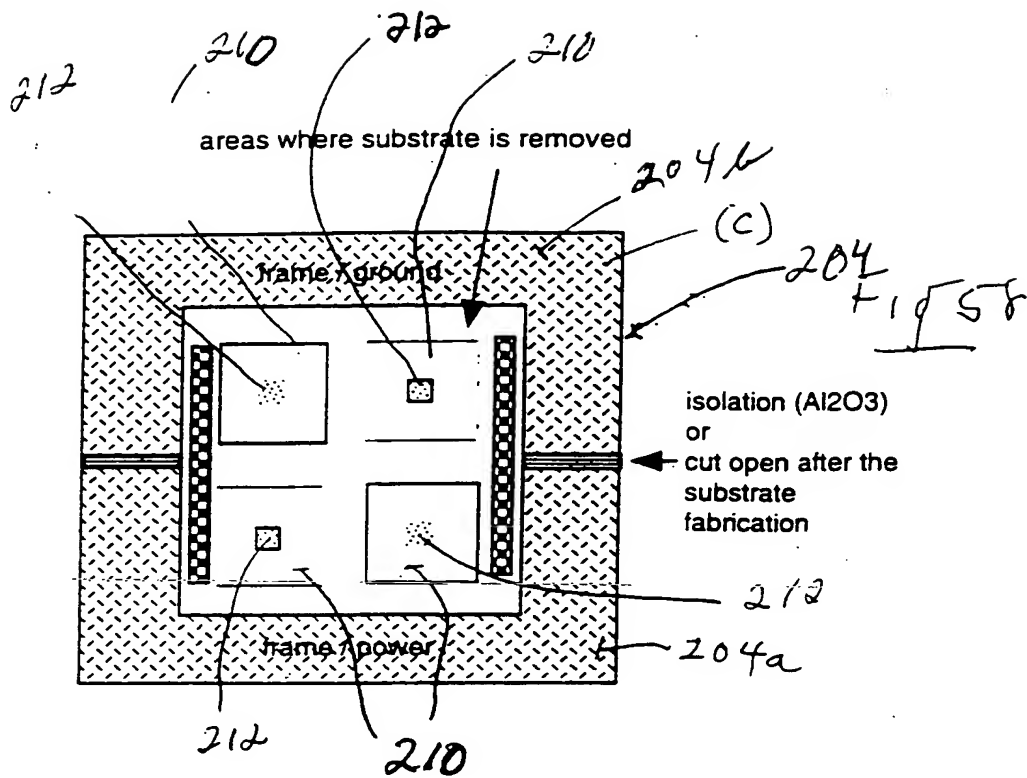
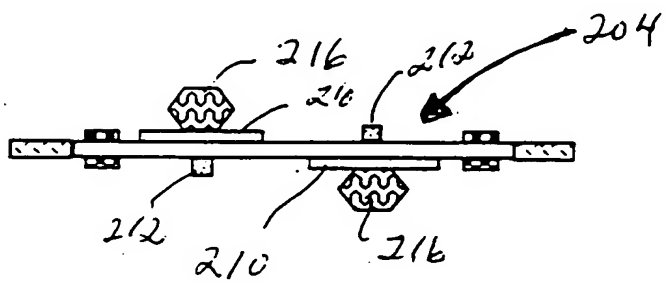
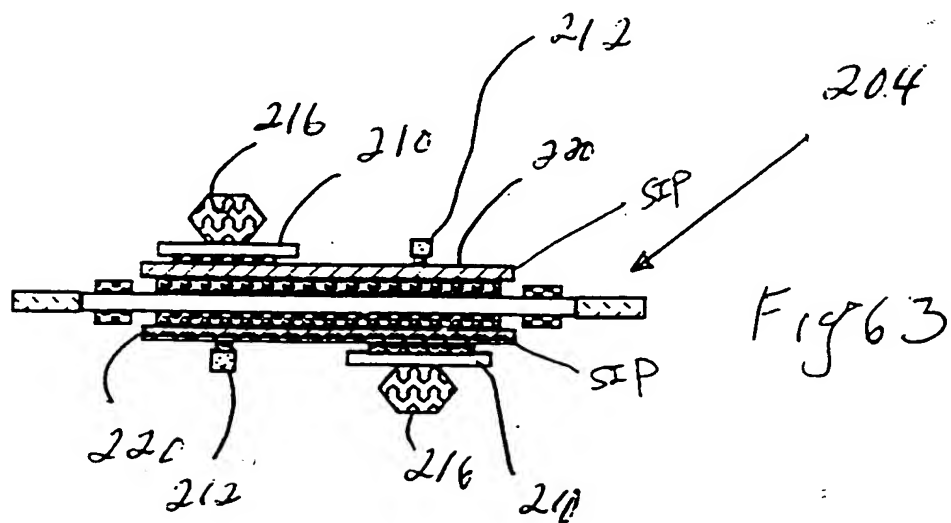
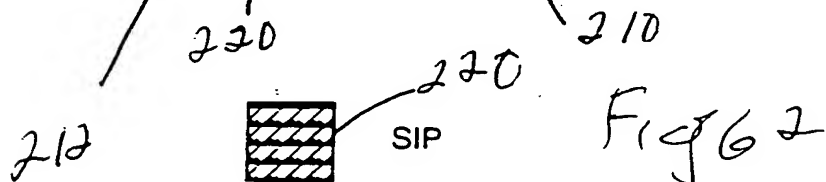
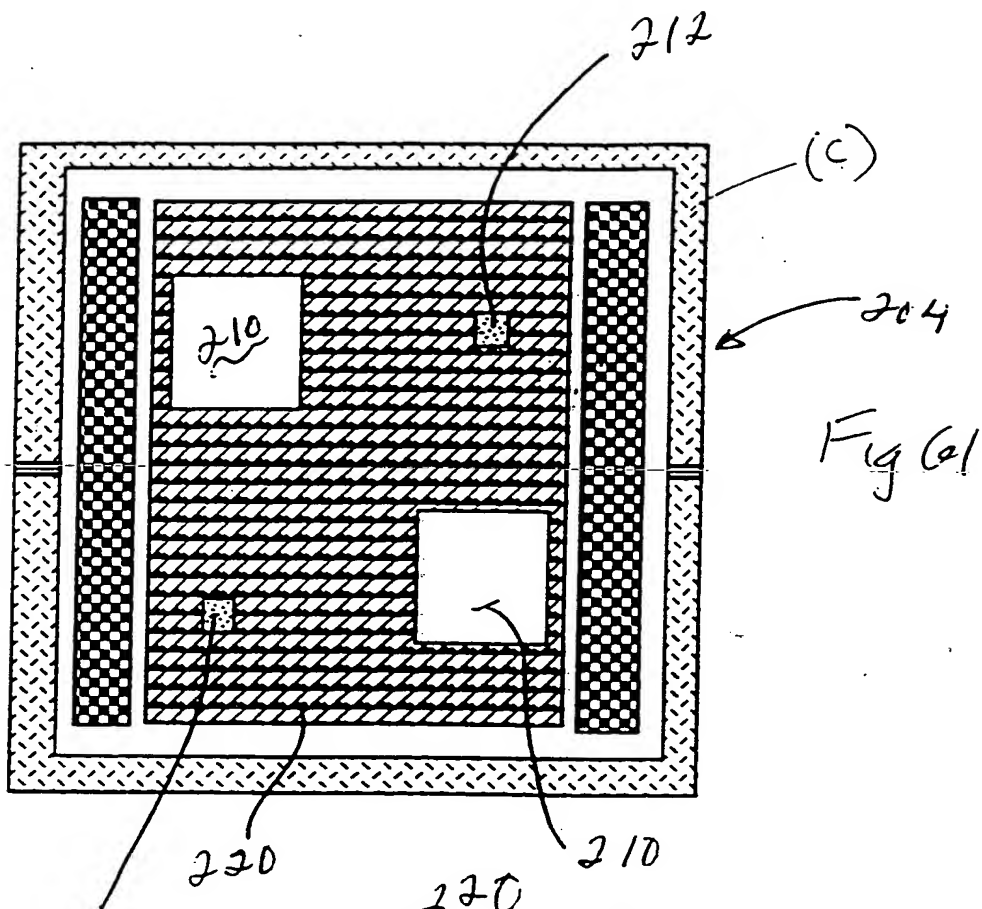


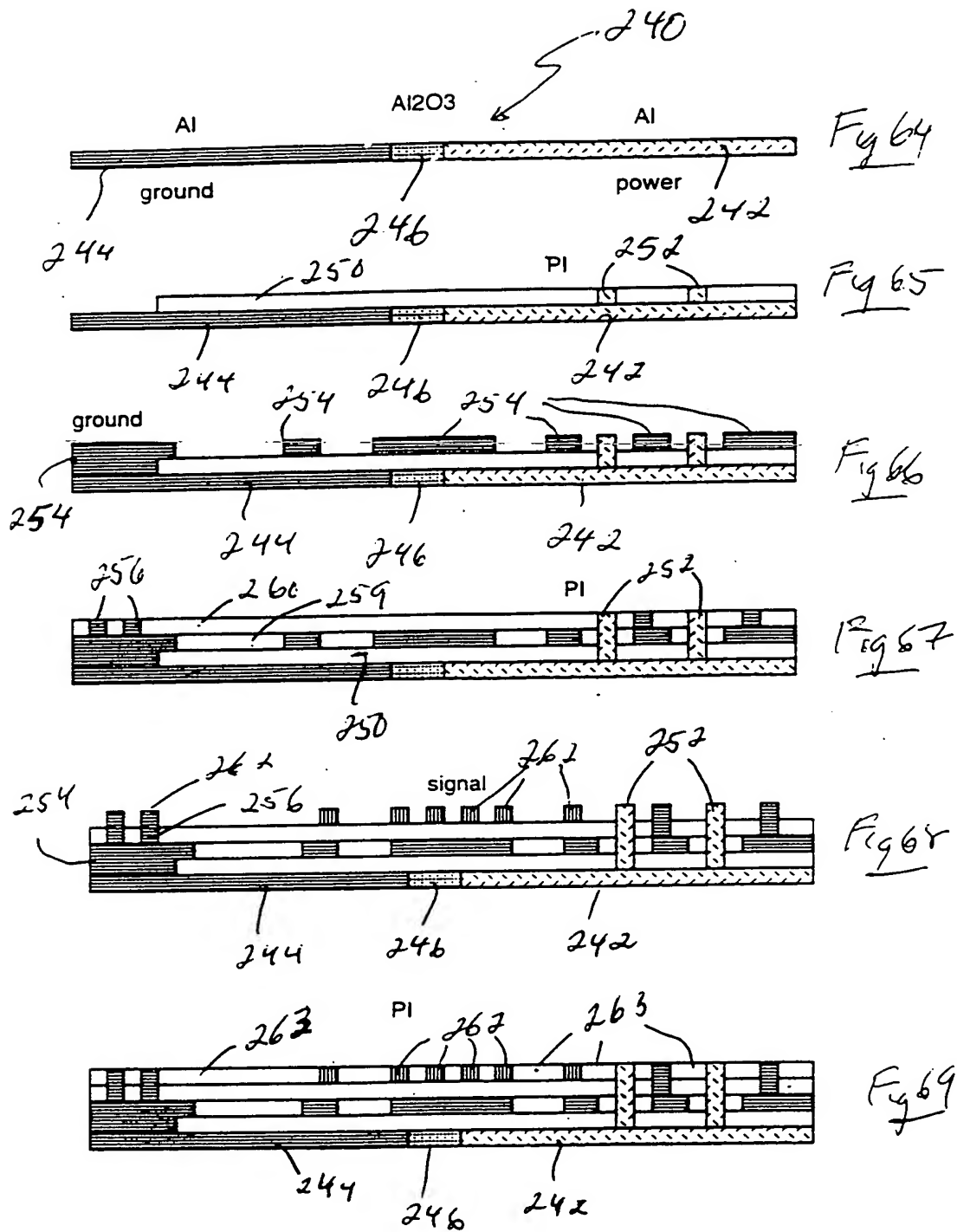
Fig 59

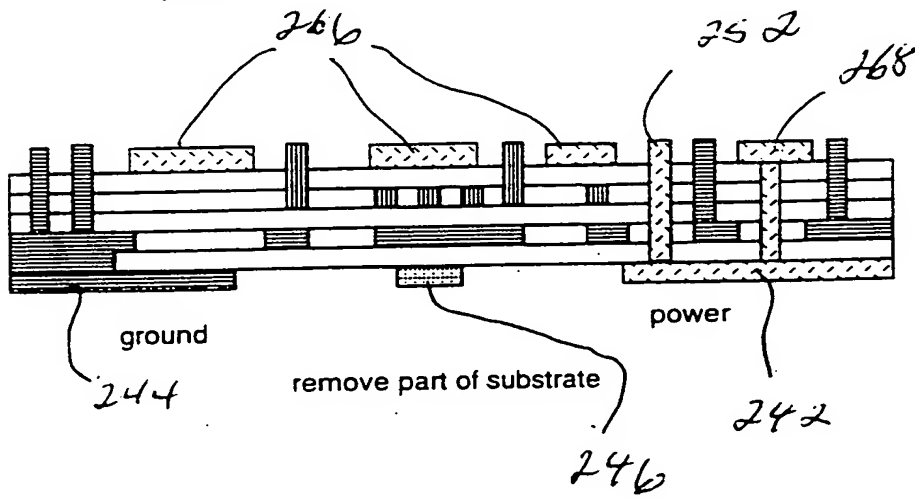
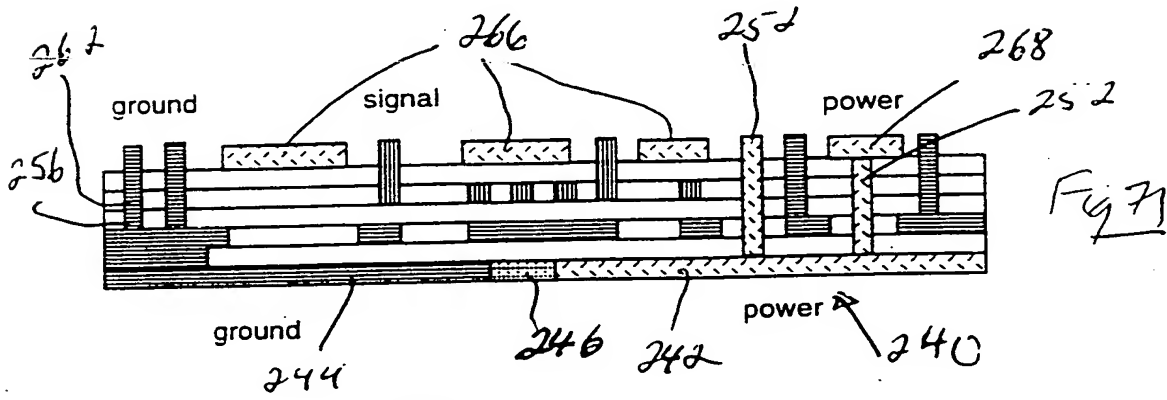
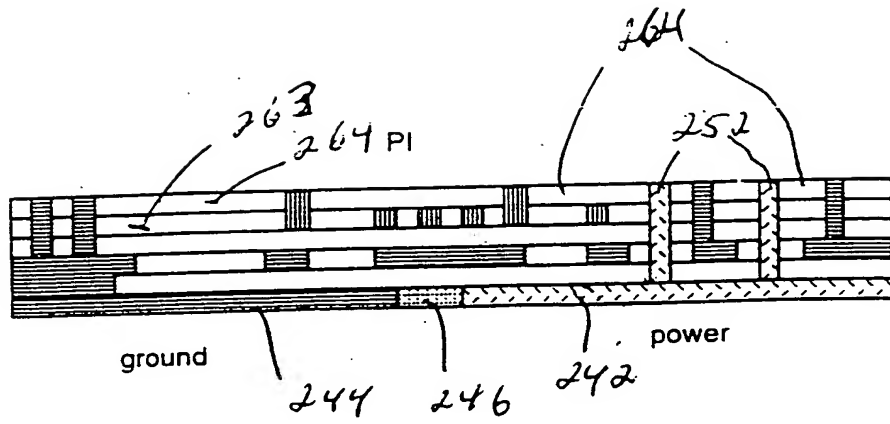


1005456 35735001

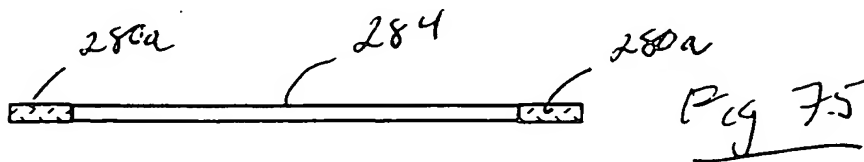
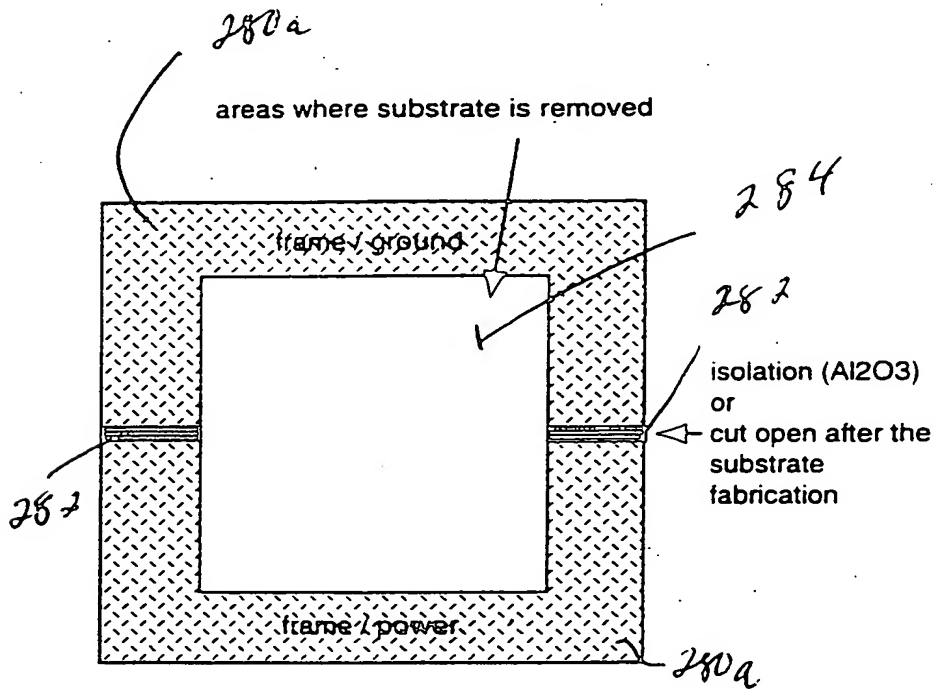
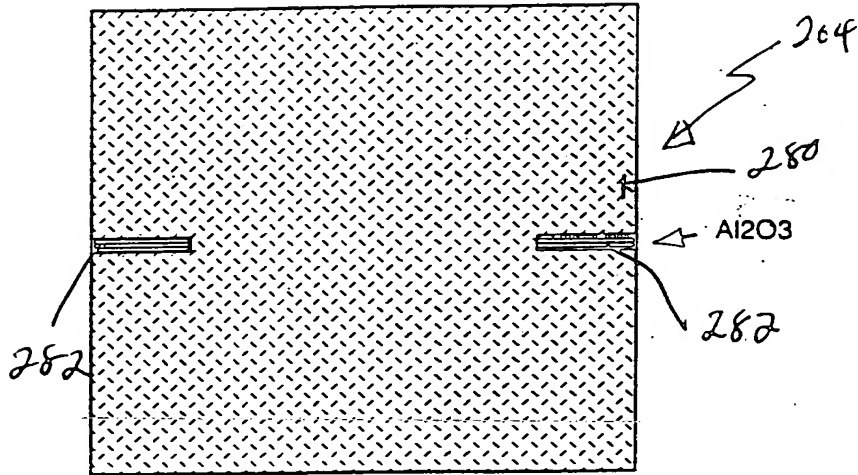






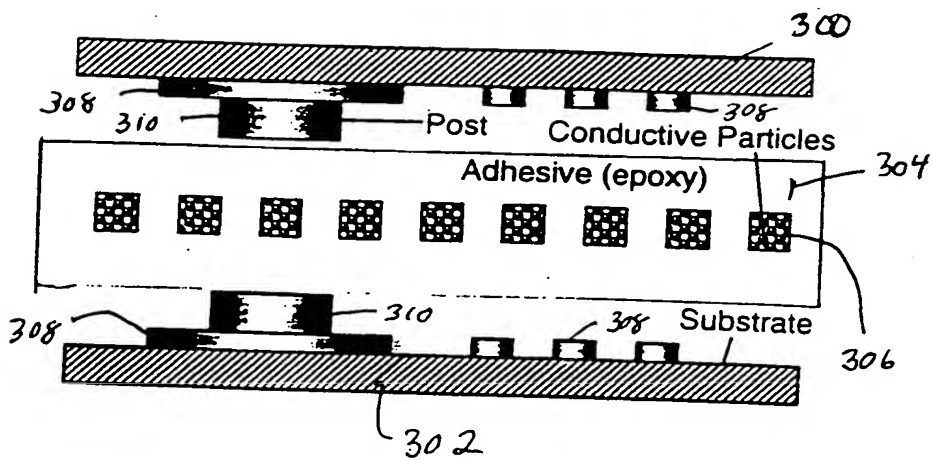
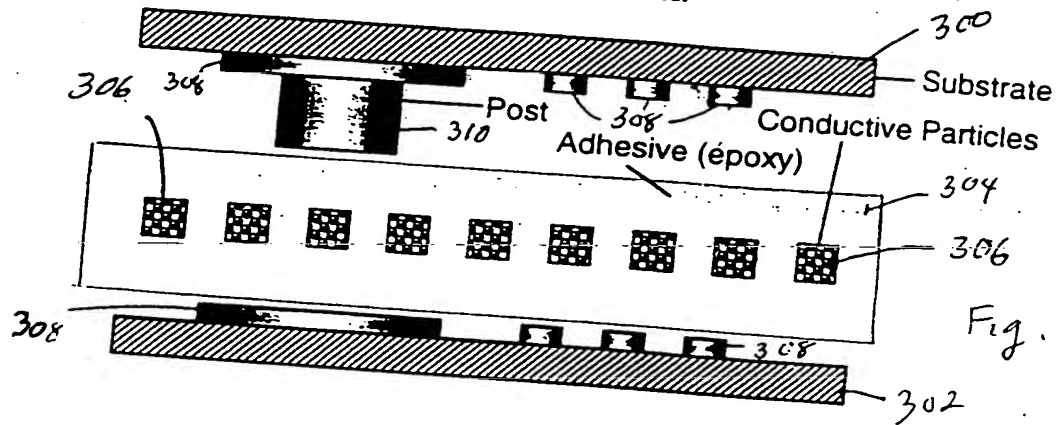


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Traditional process for anisotropic conductive film (ACF)  
connection process for joining two substrate.



ACF connection after lamination under high pressure and high temperature in traditional ACF process

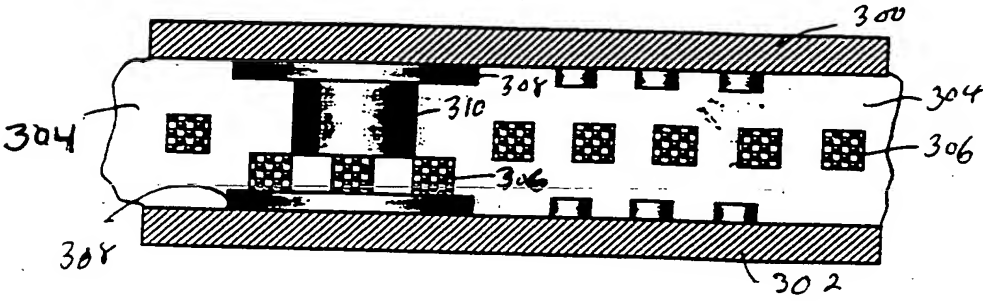


Fig 78

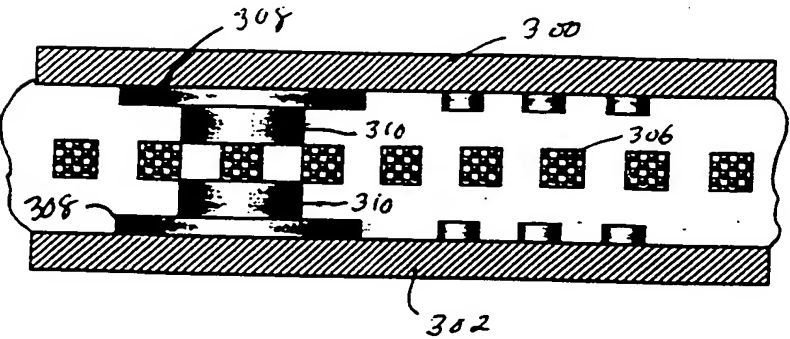


Fig 79

207020 55494007

Low resistance ACF joints by depositing a thin layer of low-melting-point metal that will form intermetallic compound/alloy between post material and conductive particles in ACF.

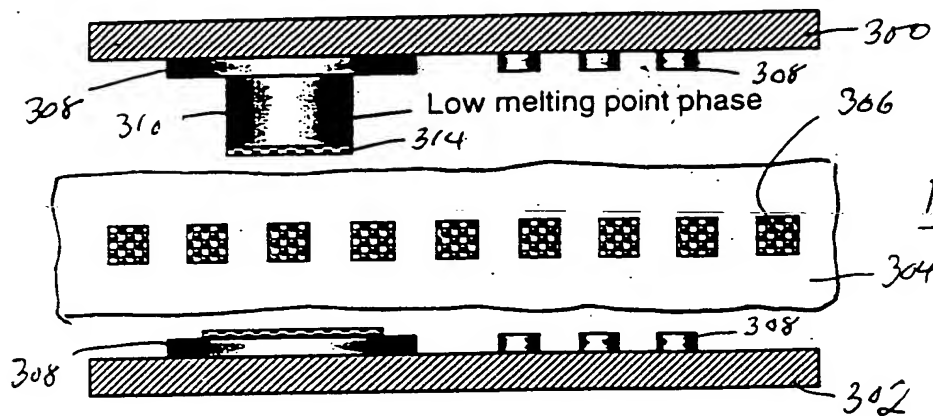


Fig 80

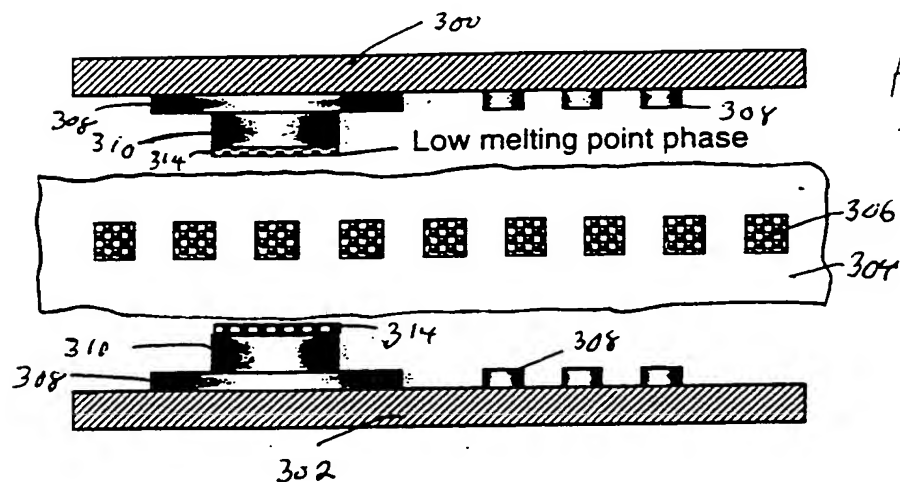
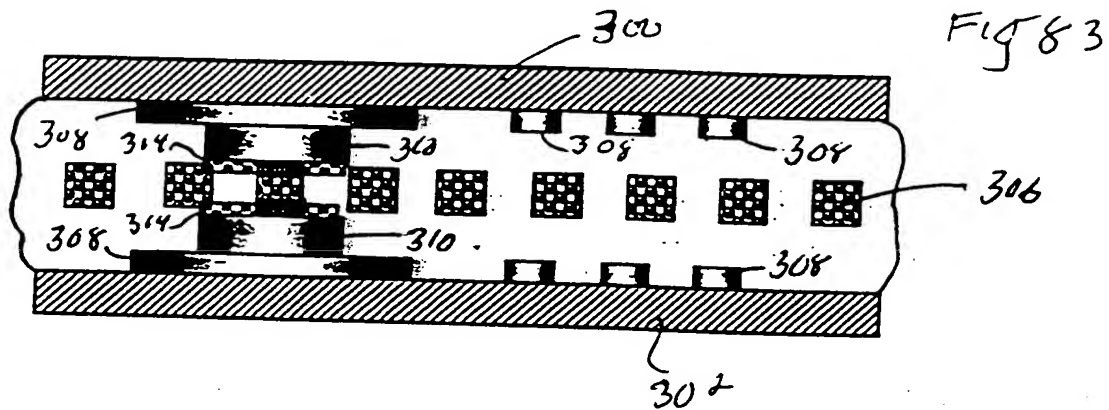
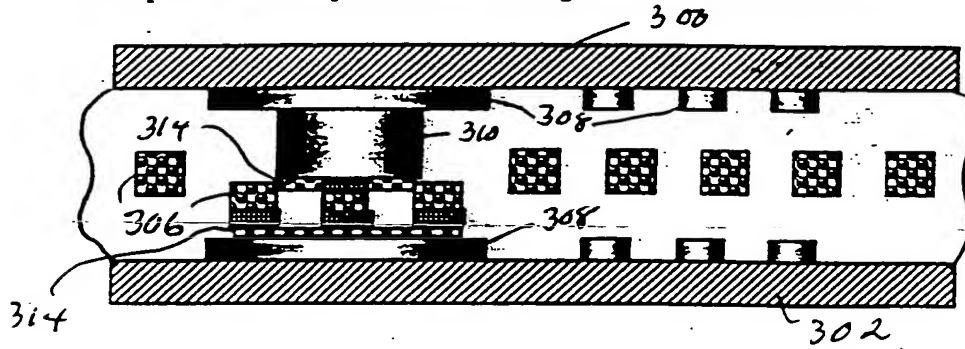


Fig 81

After joining process (high pressure and high temperature), intermetallic/alloy formed at the interface of post and conductive particles. The intermetallic/alloy will decrease the contact resistance from traditional ACF process and provide a stronger mechanical bond.



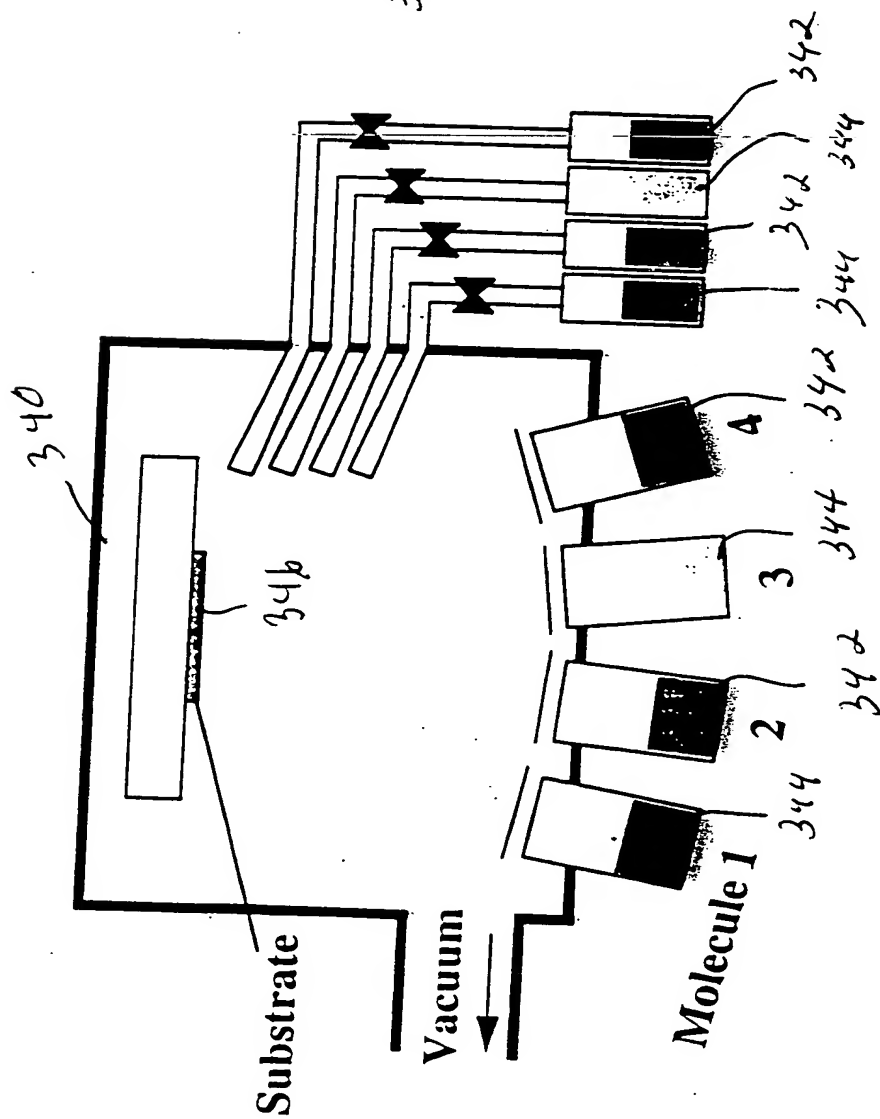


Fig 84A

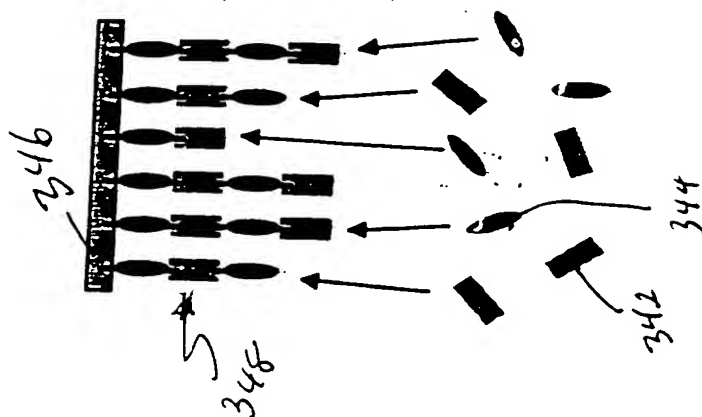


Fig-84B



Fig. 85A

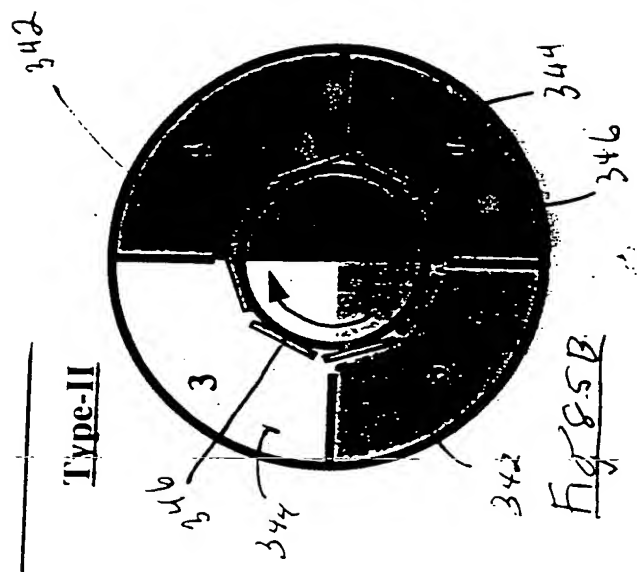
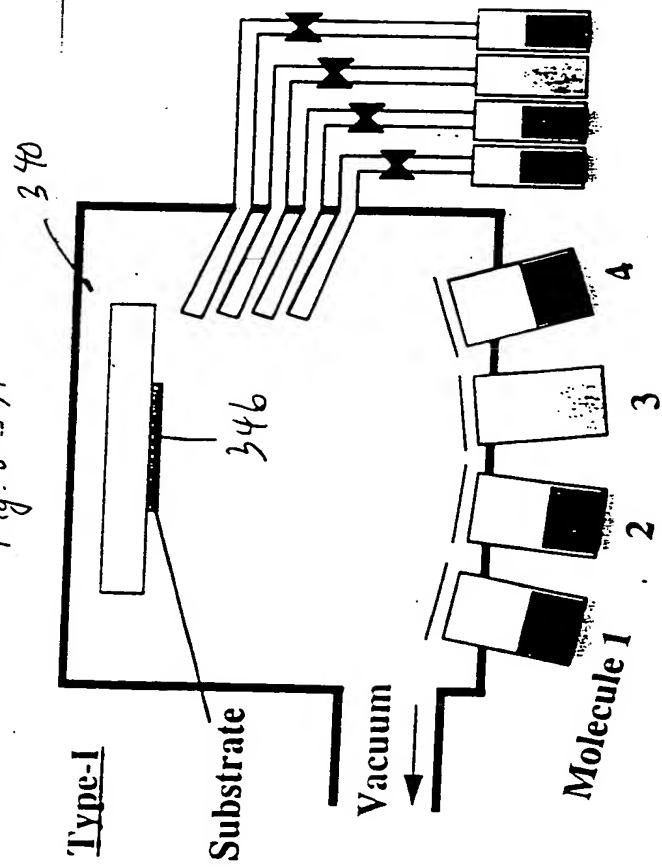
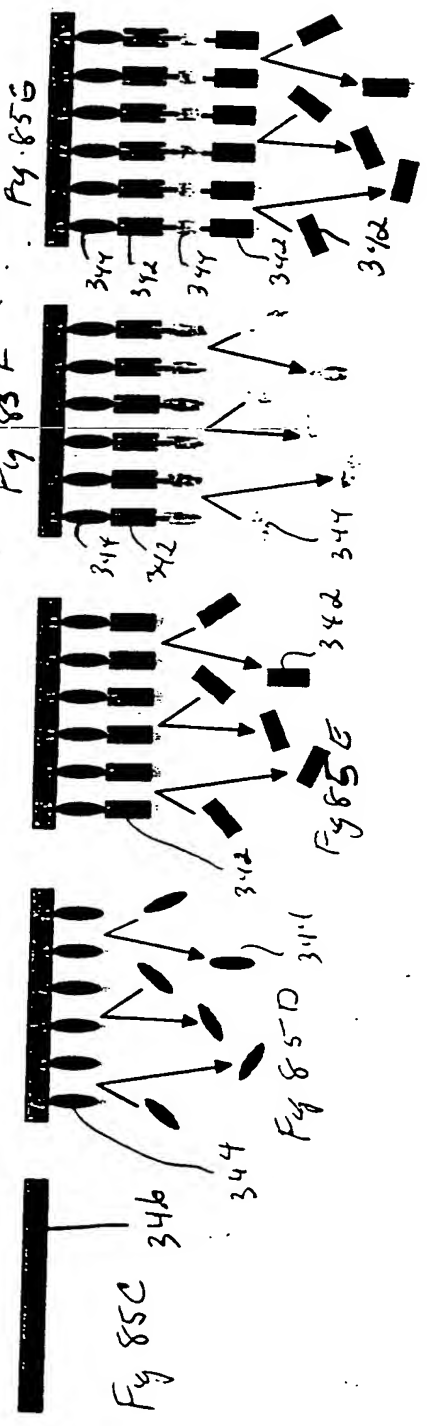


Fig. 85B



## Vapor Phase Deposition Vs. Spin coating

	Spin coating	Vapor Phase Deposition	
		CVD	MLD
-Coverage Controllability	Low	High	High
-Thickness Accuracy/Uniformity	Low	Medium	High
-Deposition Rate	High	Medium	Low
-Molecular-level Controllability	Low	Medium	High
-Selective Deposition	No	Yes	Yes
-Selective Molecular Alignment	No	Yes	Yes

(High & Yes are preferable)

-Conformable coverage and Thickness accuracy/uniformity

-CVD/MLD are superior to Spin Coating

-Low  $\epsilon$  insulator with strong adhesion

-MLD may provide high adhesion with the Molecular-Level Controllability

-Options

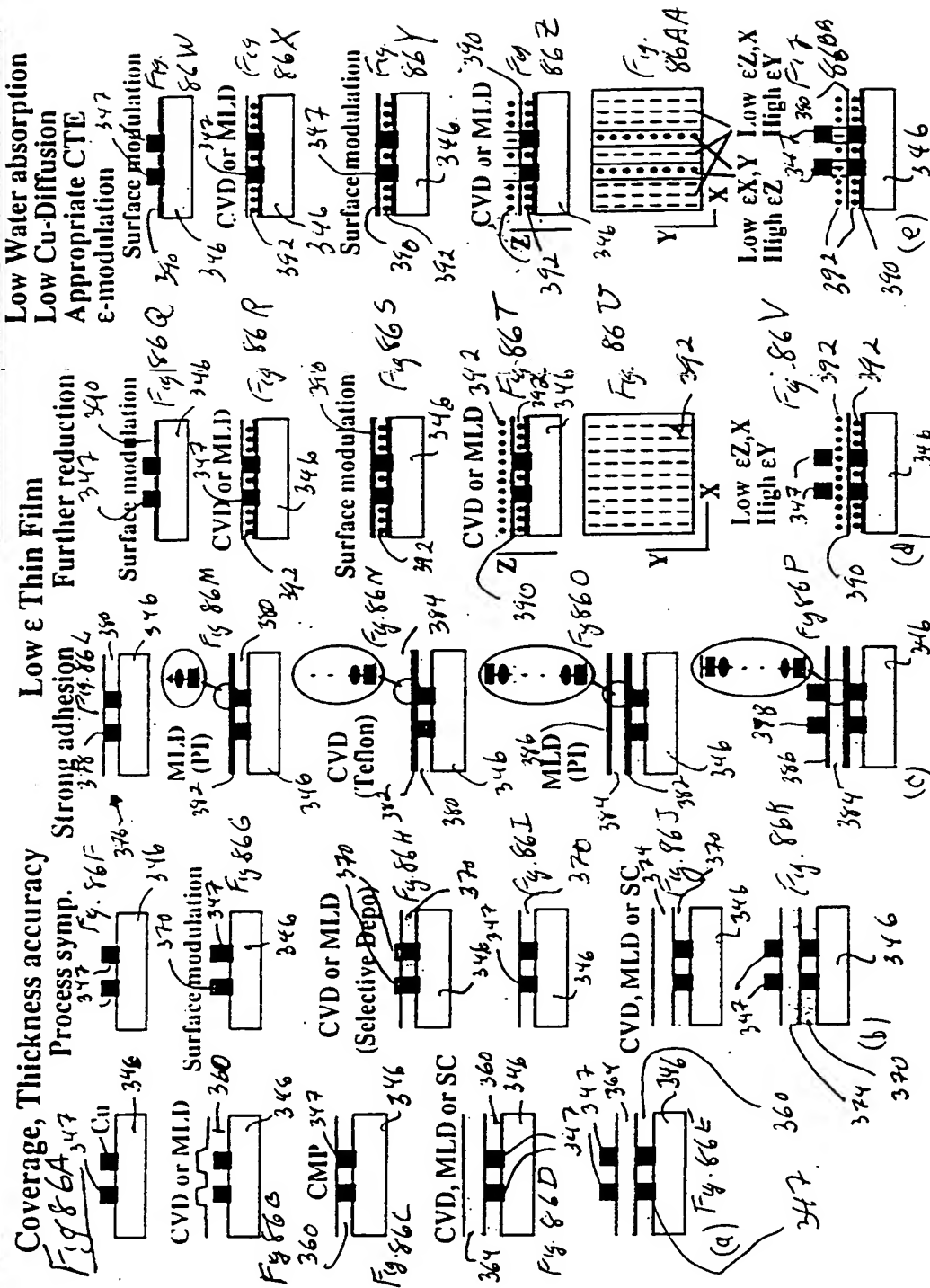
-CVD/MLD can do # Selective Deposition (hydrophilic/hydrophobic surface)

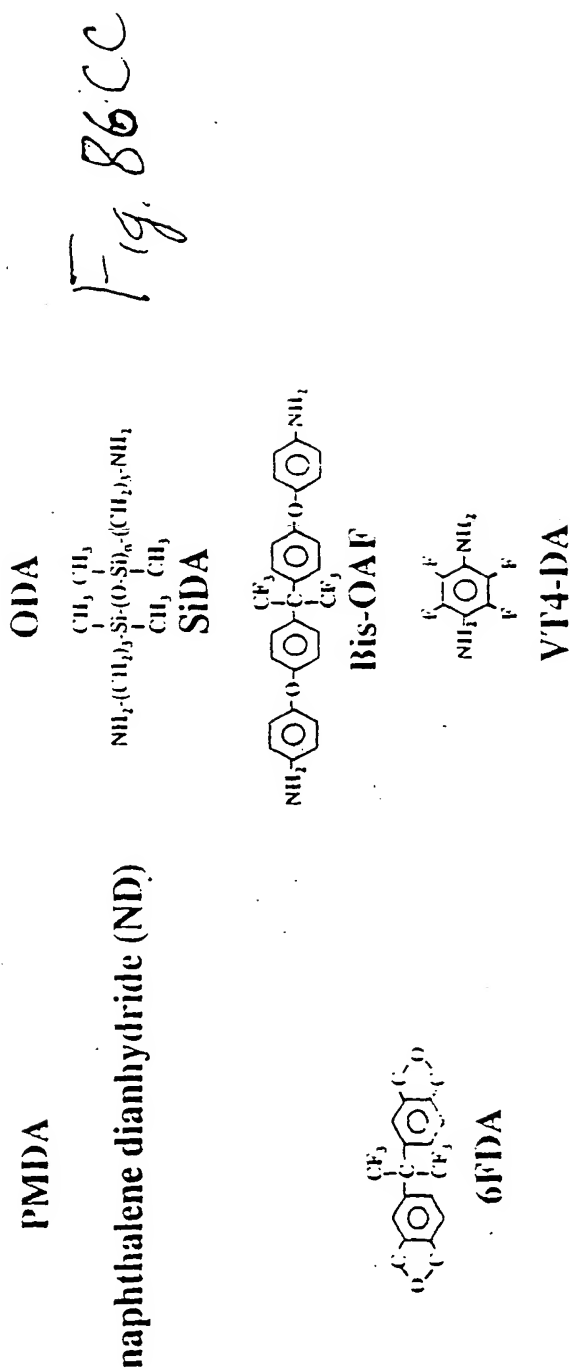
# Selective Molecular Alignment (surface treatment)

may provide further  $\epsilon$  reduction, process simplification, and low Cu-diffusion

Fig 8514

# Examples of MLD & CVD application to MCM processes





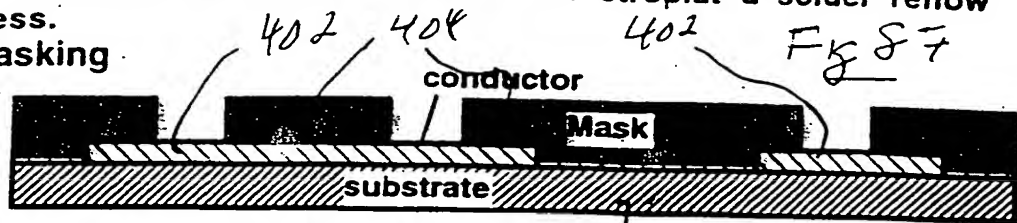
alkylamine-coated Si | ND  $\Rightarrow$  Bis-OAF  $\Rightarrow$  ND  $\Rightarrow$  Bis-OAF  $\Rightarrow$  ...  $\Rightarrow$  ND  $\Rightarrow$  SiDA

Si | SiDA  $\Rightarrow$  6FDA  $\Rightarrow$  Bis-OAF + 6FDA  $\Rightarrow$  SiDA

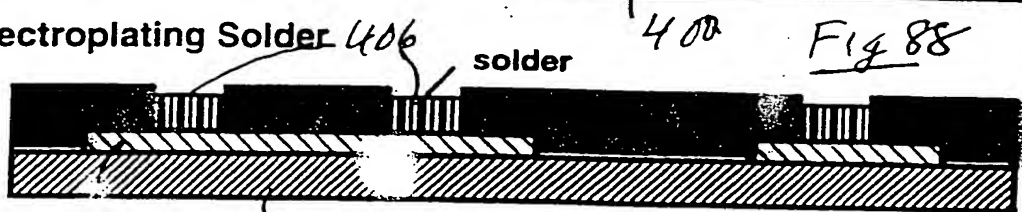
Si | SiDA  $\Rightarrow$  ODA  $\Rightarrow$  6FDA  $\Rightarrow$  VT4-DA  $\Rightarrow$  6FDA  $\Rightarrow$  ...  $\Rightarrow$  ODA  $\Rightarrow$  SiDA

Process flow of the resist-free electroplated solder reflow process.

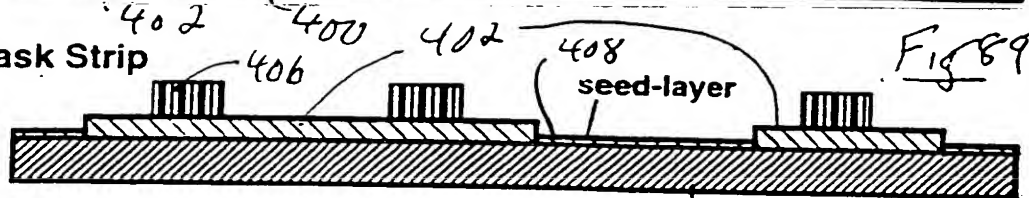
1. Masking



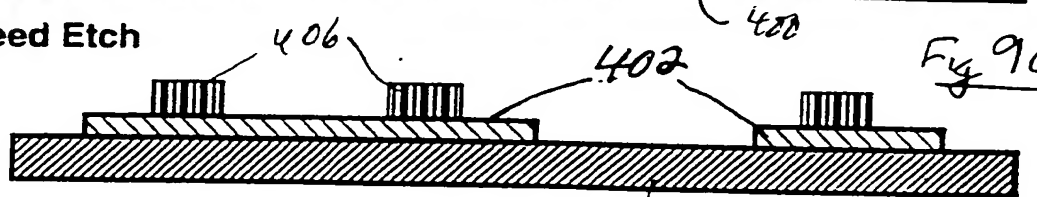
2. Electroplating Solder



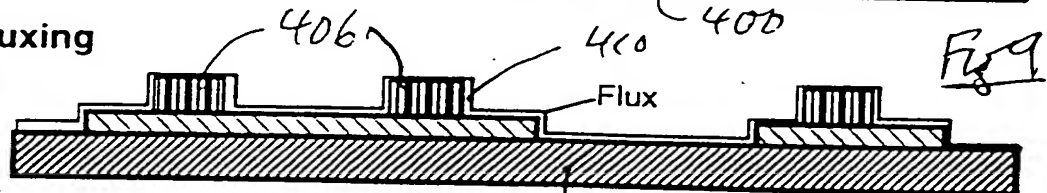
3. Mask Strip



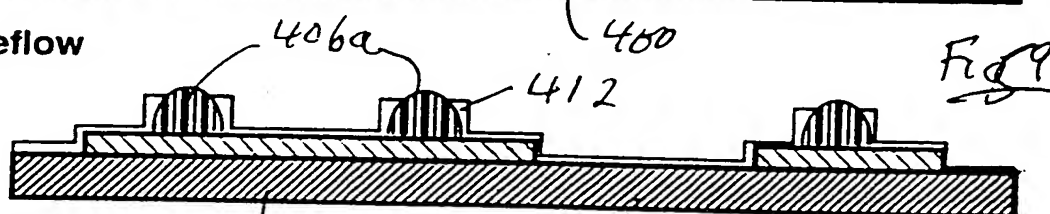
4. Seed Etch



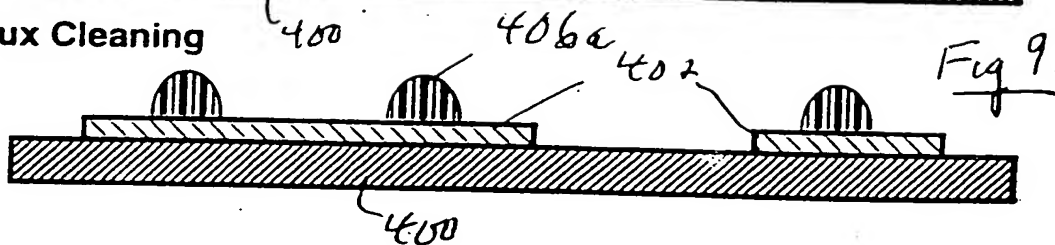
5. Fluxing



6. Reflow



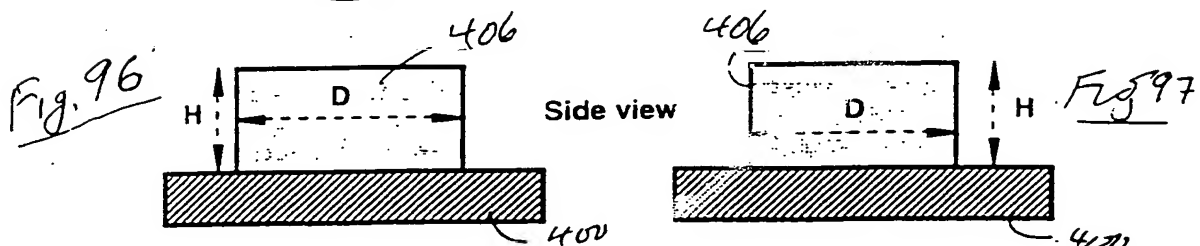
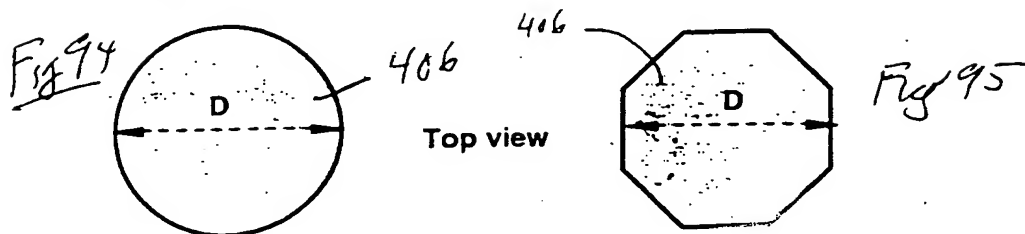
7. Flux Cleaning



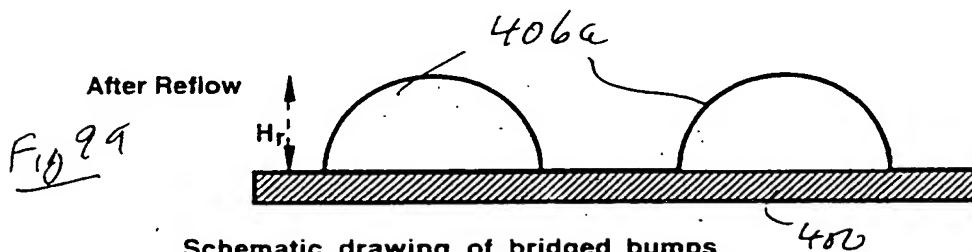
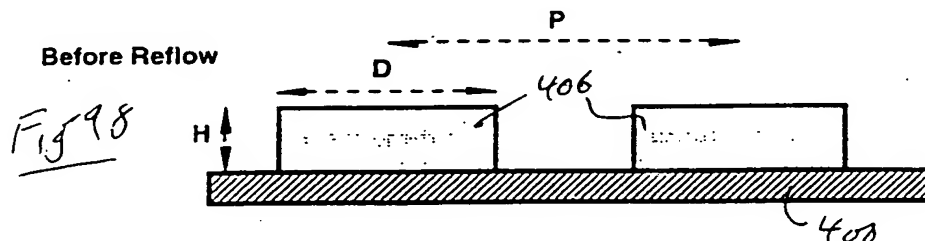
201020-55495001

1006493-02100

Geometric dimensions of the electroplated bumps.

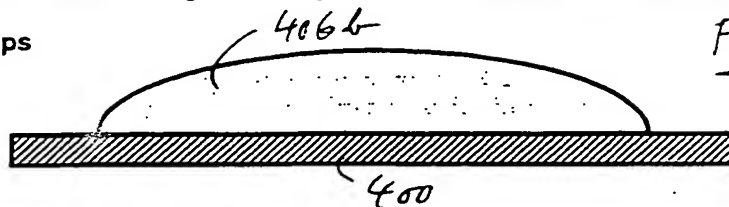


Geometric shape change of electroplated solder bumps by reflow process



Schematic drawing of bridged bumps

Bridged Bumps



## Direct Plating Process

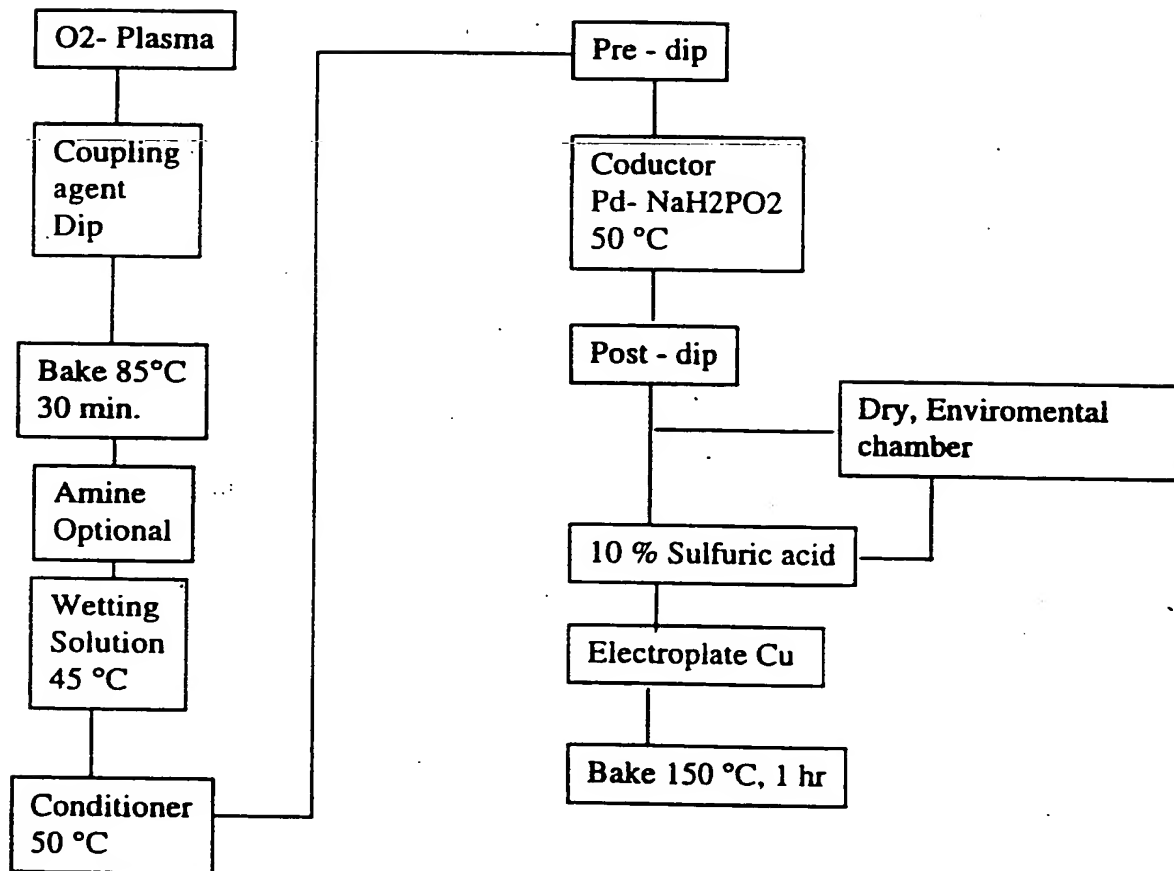
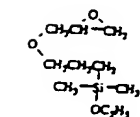
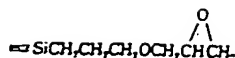
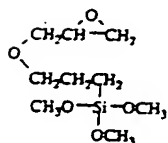


Fig 101A

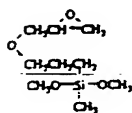
Fig 101B



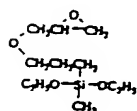
(3-GLYCIDOXYPROPYL)DIMETHYLETHOXY-SILANE  
C<sub>10</sub>H<sub>22</sub>O<sub>3</sub>Si



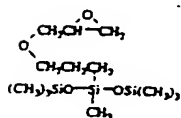
(3- GLYCIDOXYPROPYL)TRIMETHOXSILANE  
3-(2,3-EPOXYPROPOXY)PROPYLTRIMETHOXSILANE  
C<sub>9</sub>H<sub>20</sub>O<sub>5</sub>Si



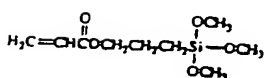
(3-GLYCIDOXYPROPYL)METHYLDIMETHOXY-SILANE  
C<sub>9</sub>H<sub>20</sub>O<sub>4</sub>Si



(3-GLYCIDOXYPROPYL)METHYLDIETHOXY-SILANE  
C<sub>11</sub>H<sub>24</sub>O<sub>4</sub>Si



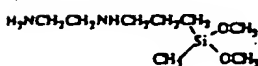
(3-GLYCIDOXYPROPYL)BIS(TRIMETHYL-SILOXY)METHYLSILANE  
C<sub>13</sub>H<sub>32</sub>O<sub>4</sub>Si<sub>3</sub>



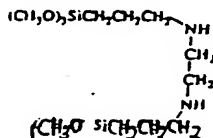
(3-ACRYLOXYPROPYL)TRIMETHOXY-SILANE, 95%  
C<sub>9</sub>H<sub>18</sub>O<sub>5</sub>Si



N-(2-AMINOETHYL)-3-AMINOPROPYLTRI-METHOXSILANE  
C<sub>8</sub>H<sub>22</sub>N<sub>2</sub>O<sub>3</sub>Si



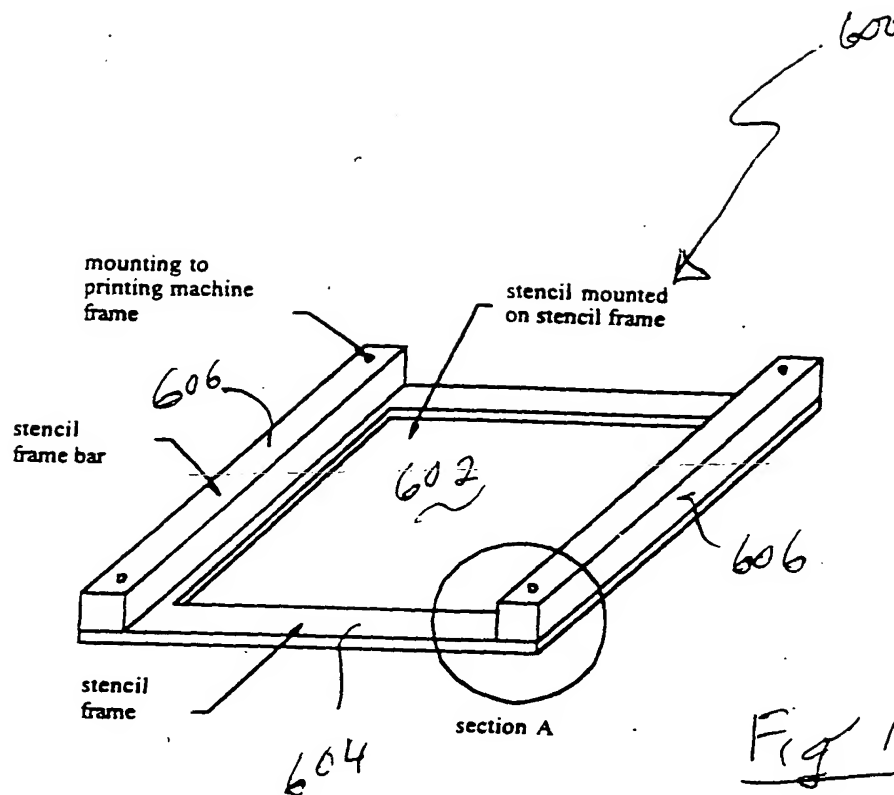
N-(2-AMINOETHYL)-3-AMINOPROPYLMETHYL-DIMETHOXSILANE  
C<sub>8</sub>H<sub>22</sub>N<sub>2</sub>O<sub>2</sub>Si



BIS[3-TRIMETHOXSILYL)PROPYL]-ETHYLENEDIAMINE,  
C<sub>14</sub>H<sub>36</sub>N<sub>2</sub>O<sub>6</sub>Si<sub>2</sub>

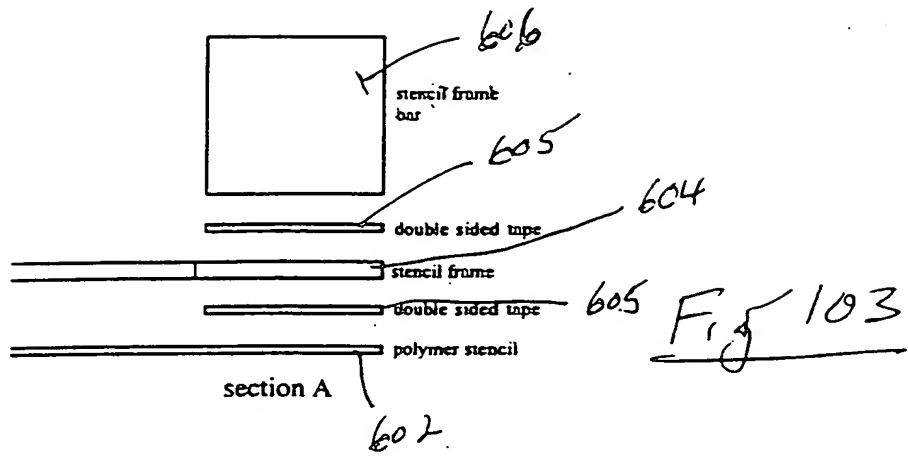
1005495 000000



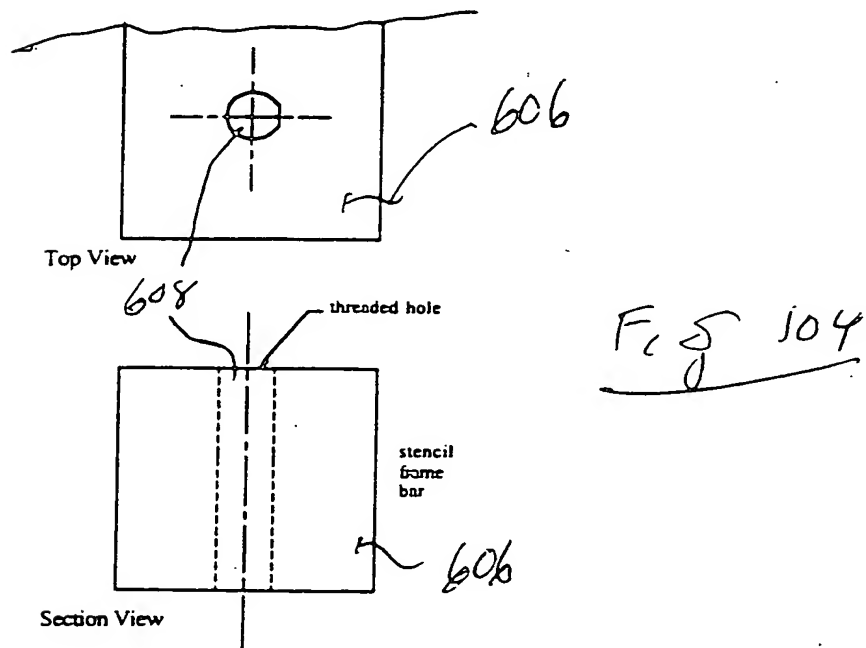


Stencil Frame Layout.

1056495-020102



Section View of Stencil Frame Components.

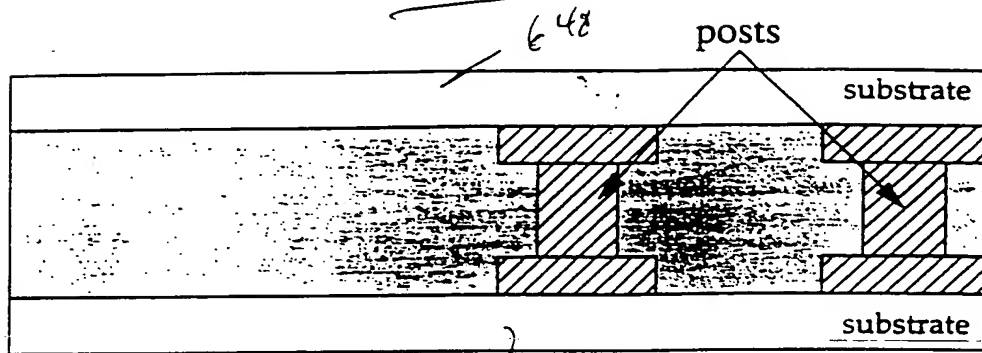


Tapped Hole in Stencil Frame Bar.

105495 020302

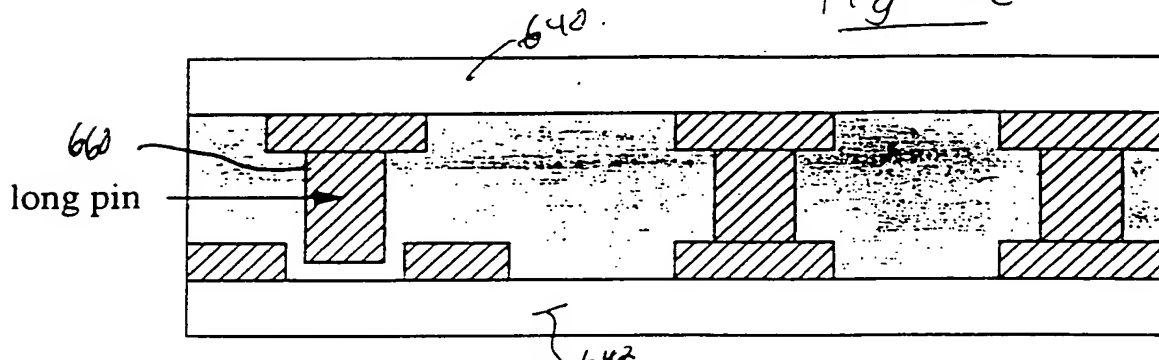
Traditional joining

Fig 105

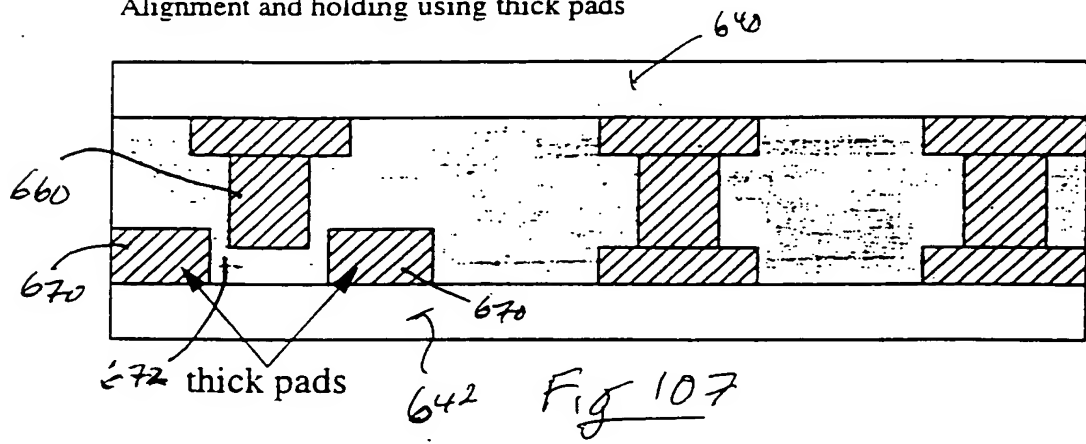


Alignment and holding using long pin

Fig 106



Alignment and holding using thick pads



Build-up process for long pin

Fig 108

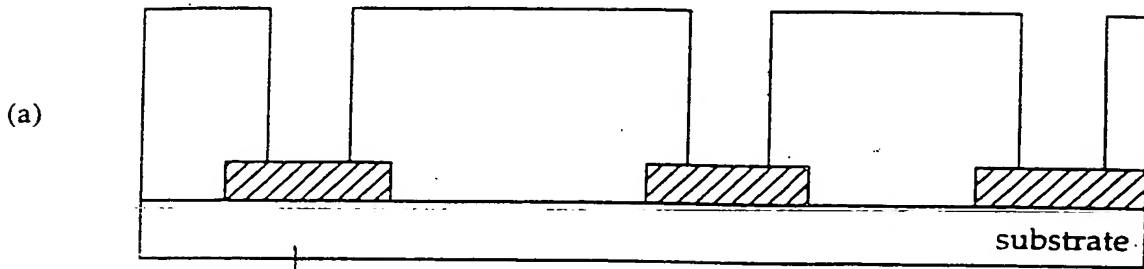


Fig 109

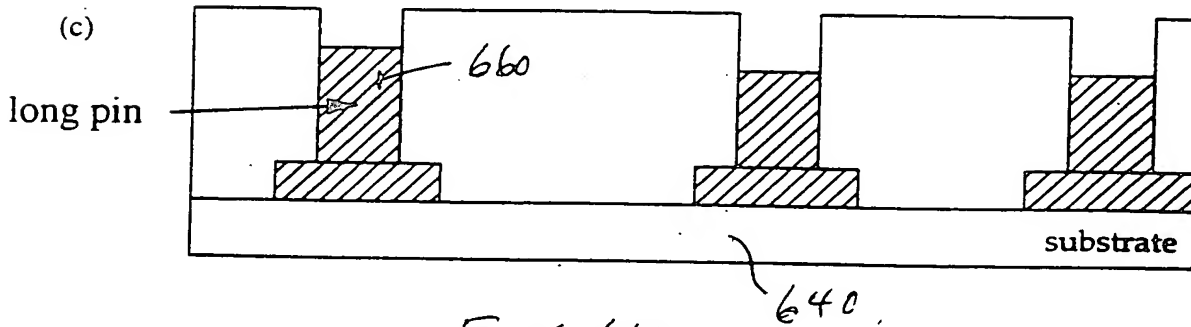
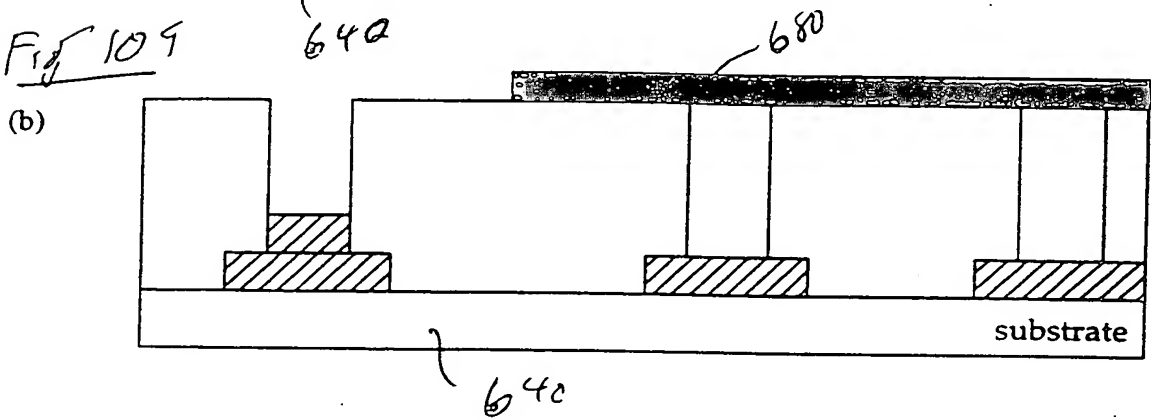


Fig 110

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10056195-020102

Fig 111

Another build-up process for long pin

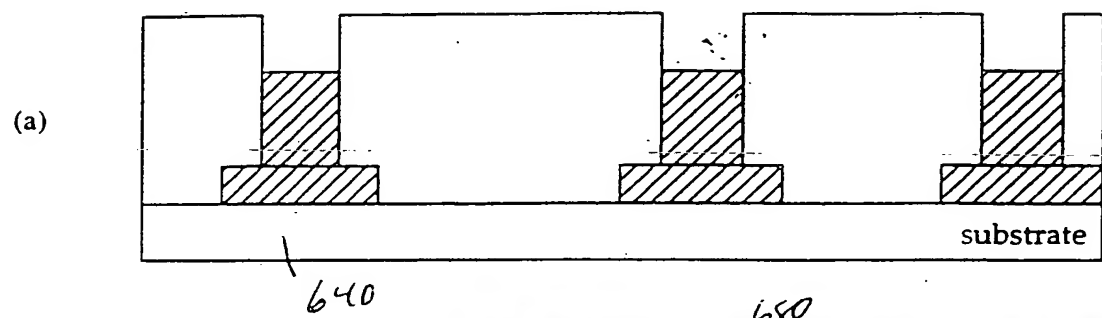


Fig 112

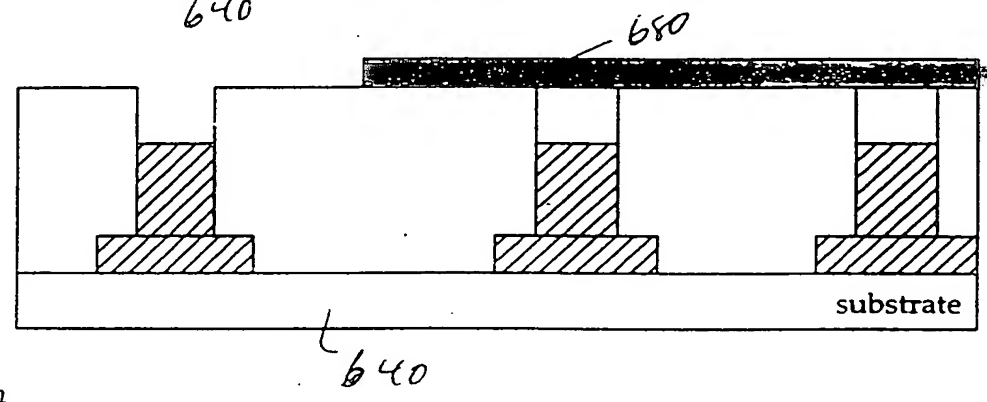
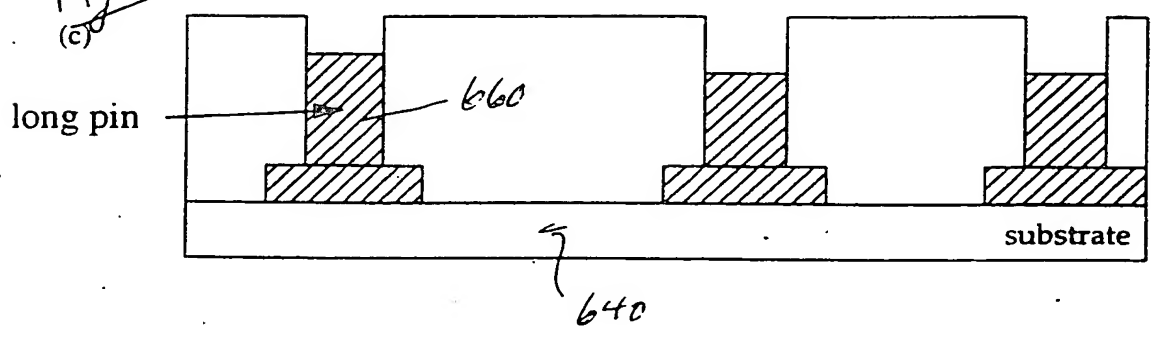


Fig 113



1065495 020402

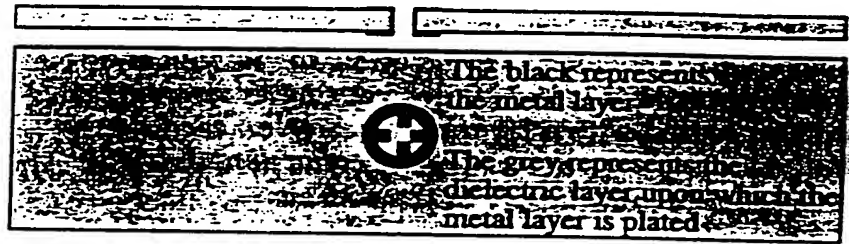
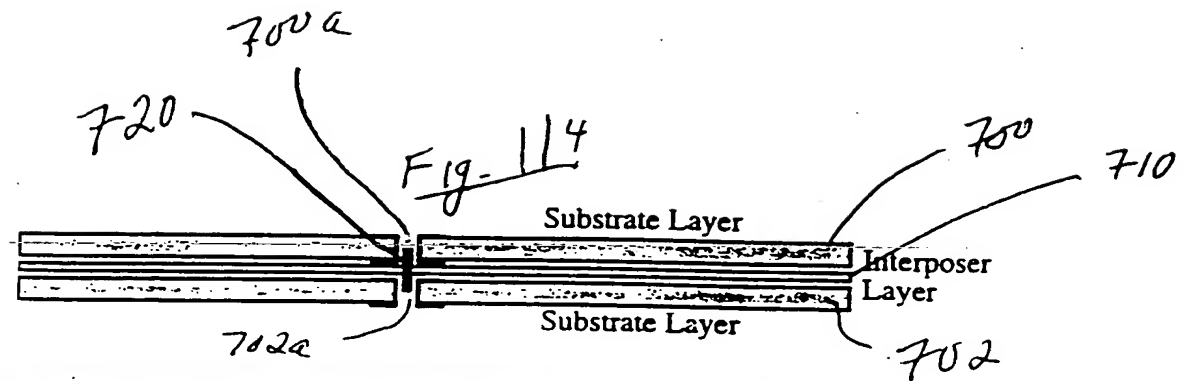


Fig 115

Transient liquid alloy bonding process with separate bonding phases.

### Transient Liquid Alloy Bonding - Type I

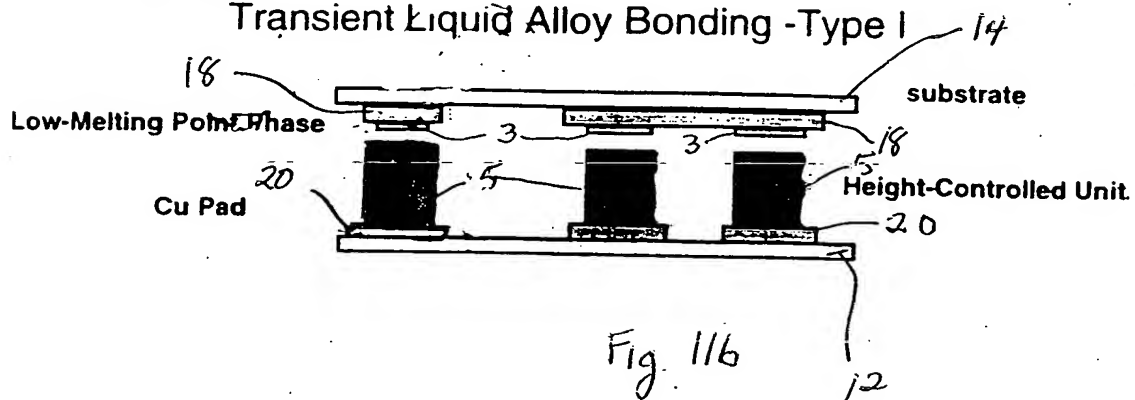


Fig. 116

Transient liquid alloy bonding process with one side bonding phases.

### Transient Liquid Alloy Bonding - Type II

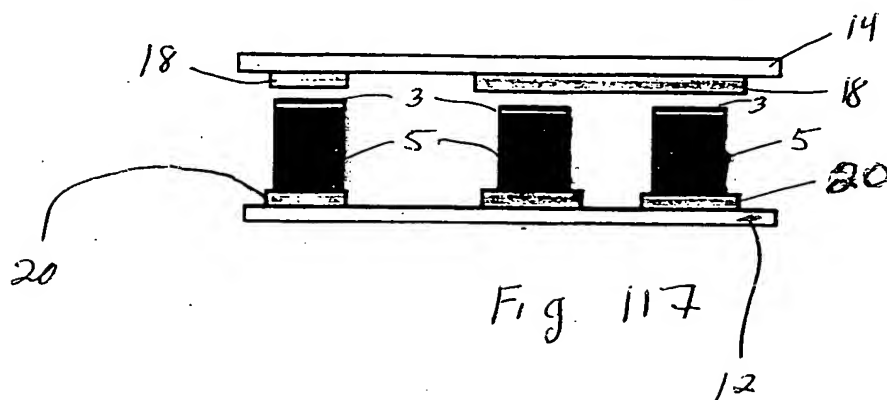
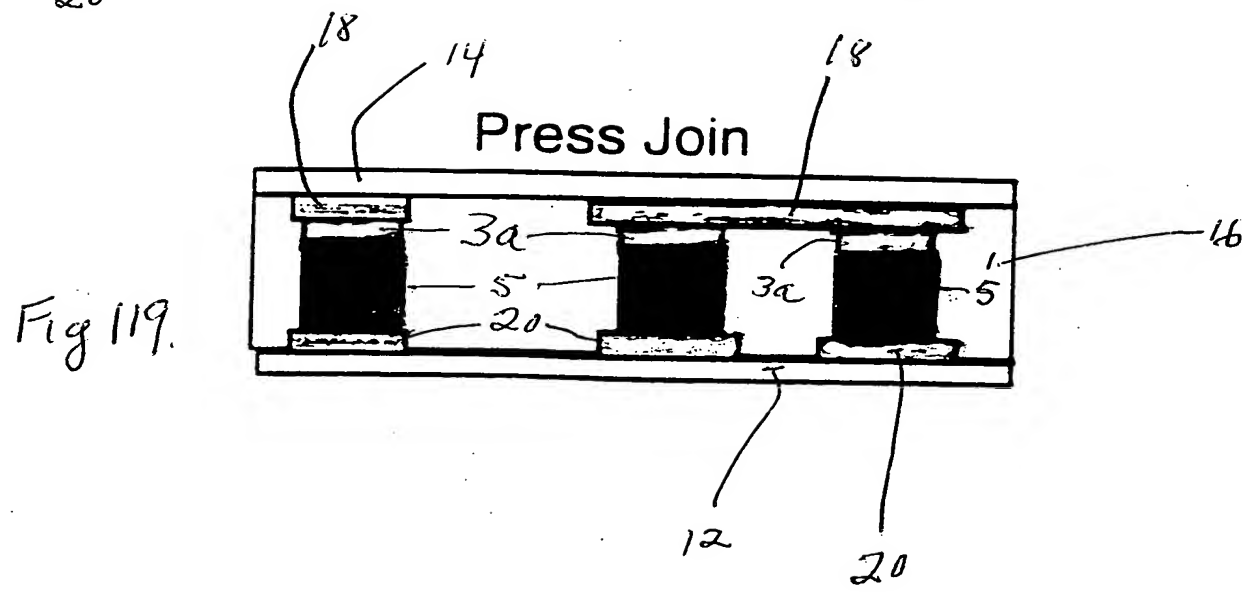
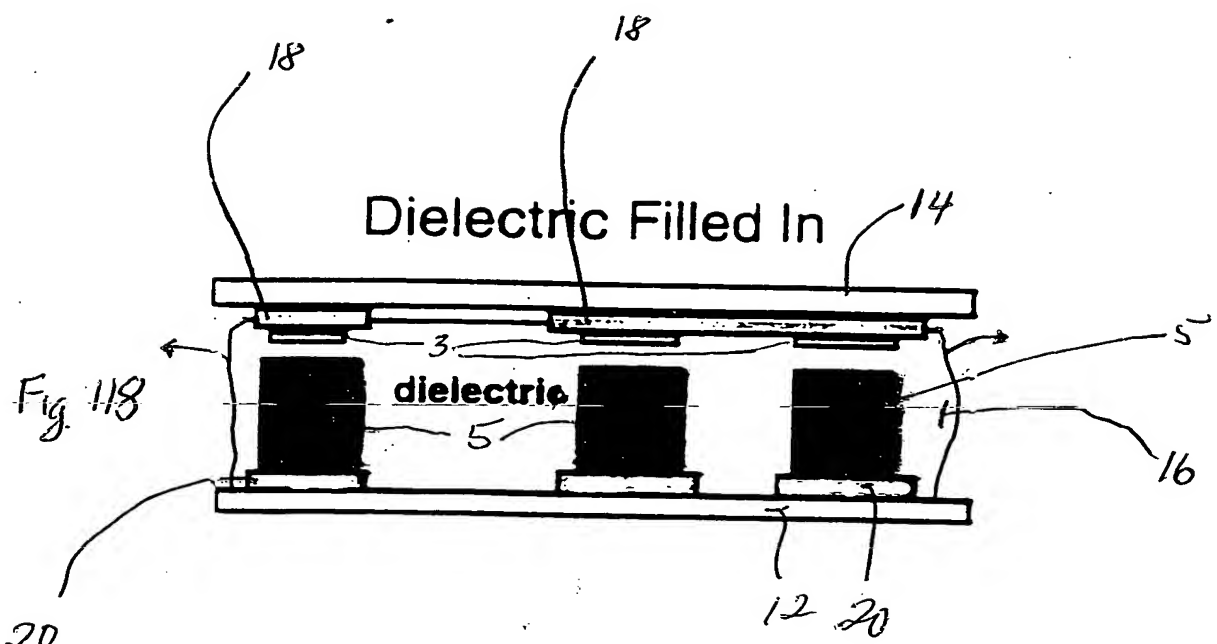


Fig. 117

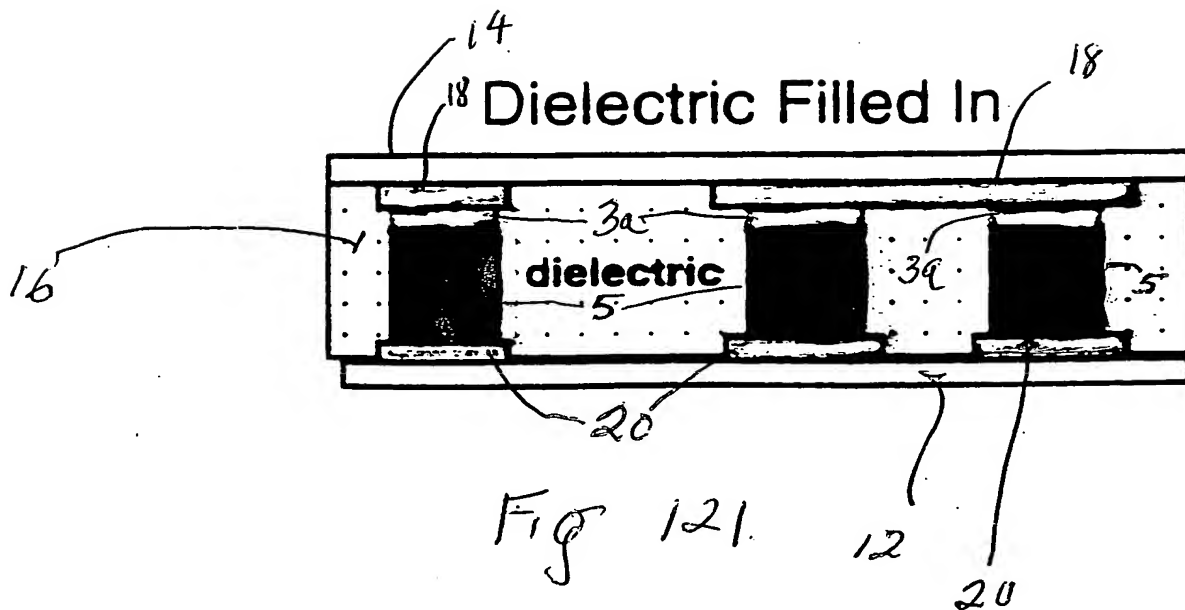
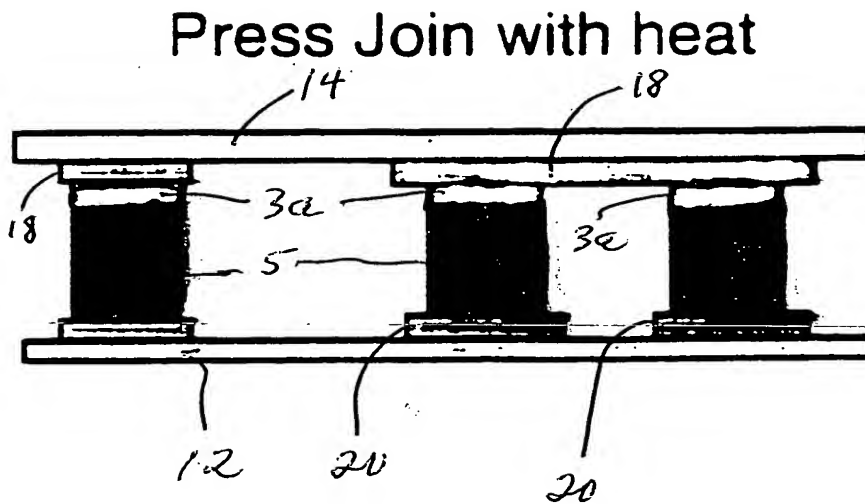
201020-5519901





1066495-020103  
201020-55495001

Fig. 120



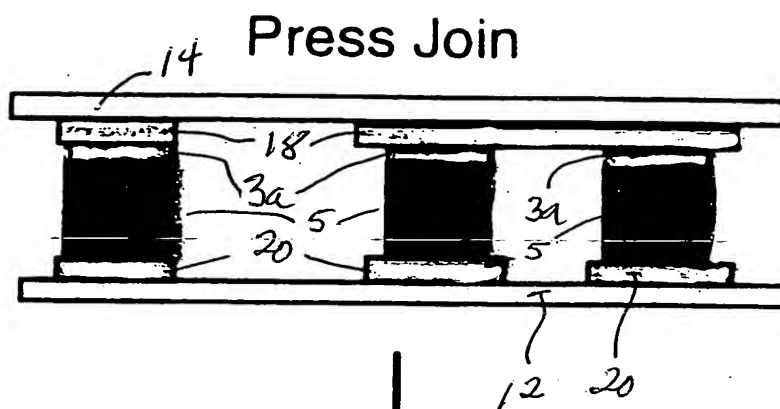
[illegible]

Fig 122.

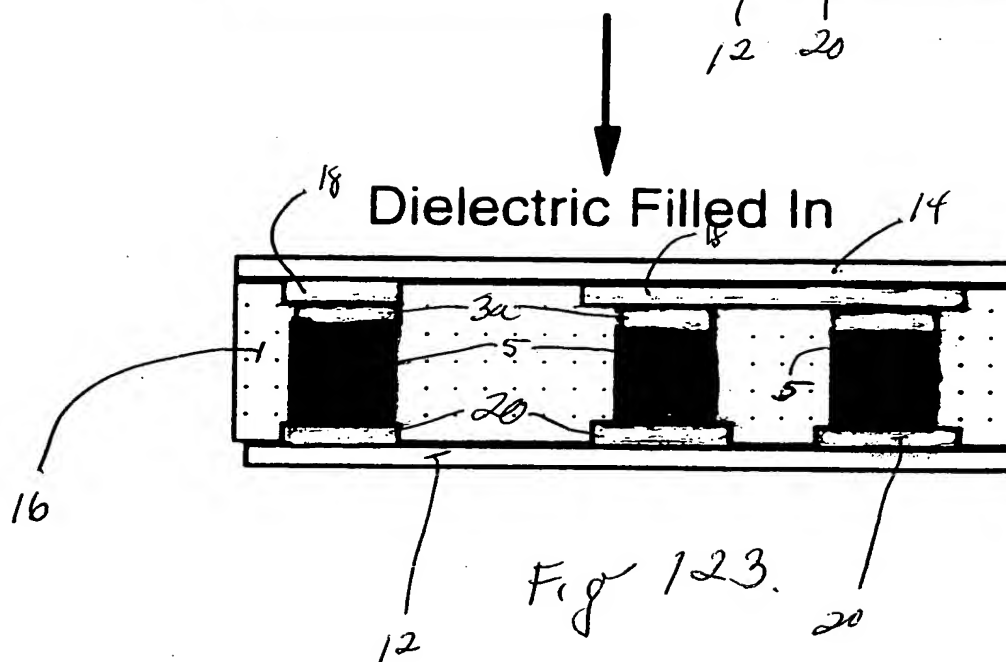
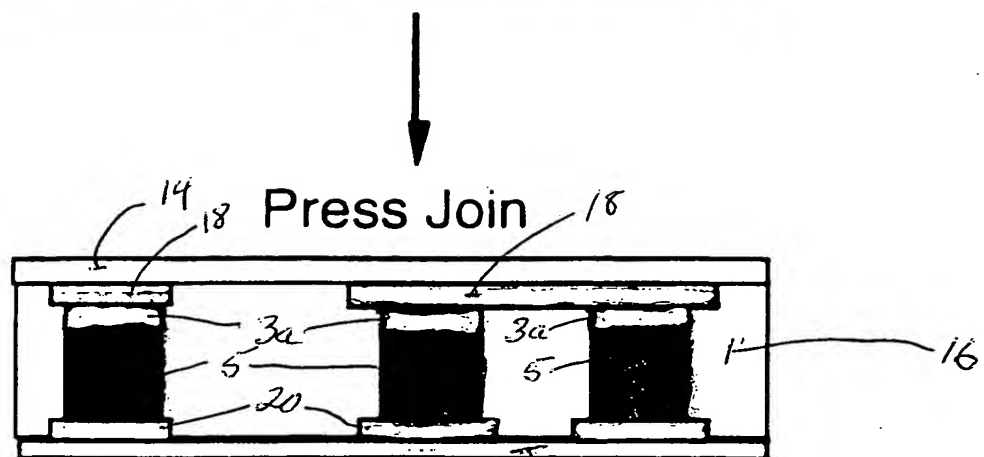
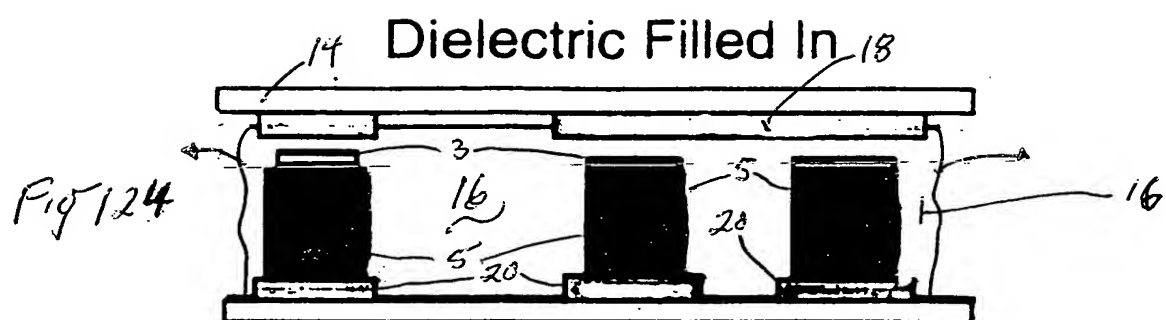


Fig 123.



F18 125

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